

EXHIBIT 58

City of Spokane



Water Quality Improvement Program

Combined Sewer Overflow Reduction System Wide Alternative Report

December 2005

Prepared By:



Taylor Engineering, Inc.

CTE Project No. 71240-0300

Combined Sewer Overflow Reduction System Wide Alternative Report

December 2005

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned whose seal as a professional engineer licensed to practice as such in the State of Washington is affixed below.

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Executive Summary

Introduction

The objective of this plan amendment is to address the revised Code of Washington (RCW) 90.48.480 which requires the control and reduction of combined sewer overflows (CSO) for the City of Spokane (City). This would be accomplished through implementation of a system wide approach to CSO control. The State regulatory requirements for CSO reduction can be summarized in the following excerpt:

The Department of Ecology shall work with local governments to develop reasonable plans and compliance schedules for the greatest reasonable reduction of CSOs. The plan shall address various options, including construction of storage tanks for sewage and separation of sewage and stormwater transport systems. The compliance schedule shall be designed to achieve the greatest reasonable reduction of CSOs at the earliest possible date.

Combined sewers carry sanitary sewage and stormwater runoff in the same conveyance system. During rainfall events in which excessive amounts of stormwater enter the combined sewer system, excess combined sewage may be diverted to the Spokane River. These diversion points in the collection system are called CSO regulators. CSO regulators both control flow rates to the interceptor system and divert flows in excess of these flow rates to the Spokane River. Once diverted, the overflow volume is discharged without treatment to the Spokane River through outfall pipes. These outfalls are allowed under the City's National Pollution Discharge Elimination System (NPDES) Permit. Several CSO regulators may discharge to a common outfall. The drainage area contributing sanitary sewage and stormwater to a CSO regulator is called a CSO Basin. **Figure ES-1** illustrates the location of the CSO outfalls; the extent of the City's combined sewer system; and the extent of the interceptor system.

The Washington State Department of Ecology (Ecology) promulgated regulations (Chapter 173-245 WAC) which limit CSOs to an average of one untreated overflow per year per outfall, with the discharge complying with water quality standards in the receiving water. Ecology's renewal of the City's NPDES Permit of 1992 required the City to prepare a CSO Reduction Plan.

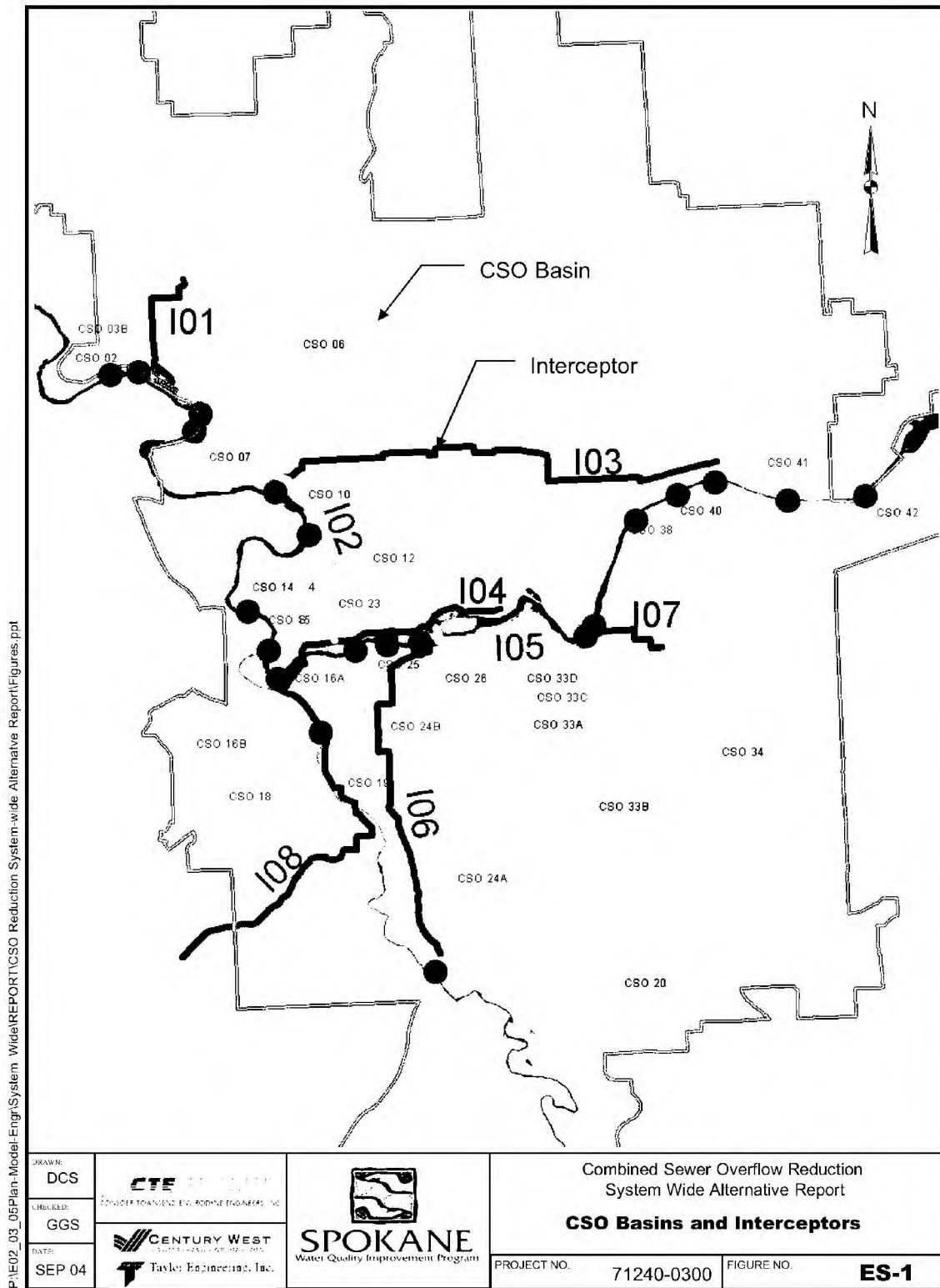
In addition to state regulations, the U.S. Environmental Protection Agency has issued a set of control strategies for combined sewer overflows called the "Nine Minimum Controls." The intent of these policies is to ensure that the controls are cost effective and meet the requirements of the federal Clean Water Act.

Historical Compliance Actions

The City of Spokane had initiated a program to address CSO discharging to the Spokane River beginning with the *Facilities Planning Report for Sewer Overflow Abatement* (City of Spokane, 1977). Based upon this plan the City in the 1980s implemented a \$43 million storm separation construction program which reduced annual CSO volume by 491 million gallons (eighty-six percent). Sixty-four percent of the City's developed sewer service area was separated.

In response to the 1992 NPDES Permit, the City developed the *Combined Sewer Overflow Reduction Plan* (Bovay, 1994) which reviewed the status of CSO reduction effort and proposed additional actions and improvements for CSO reduction.

In March 2000, the CSO program was revised to incorporate a comprehensive review of the combined sewer systems (CSSs) and the interceptor system. The objective was to maximize the use of both interceptor and the Riverside Park Water Reclamation Facility (RPWRF); and provide sufficient CSO reduction to comply with State of Washington regulations, Chapter 173-245 WAC.



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System Wide Approach

This report and its recommended system wide alternative amend the City's *Combined Sewer Overflow Reduction Plan* (Bovay, 1994) and the preferred alternative specified therein. This document provides an overview of the development, screening, and recommendation of the preferred system wide alternative for CSO reduction for the City.

The system wide analysis included conducting multiple simulations of the collection and interceptor system to determine the system's response to various CSO reduction or control configurations. This was accomplished through the development of a system wide model. This model is an enhancement to the former model used in the preparation of the 1994 Plan.

Existing Base Wastewater Flows (BWF) were based upon observed or monitored flow rates. Flows from Spokane County, City of Spokane Valley, City of Airway Heights, and Fairchild Air Force Base were also derived from measurements. Other flow components such as groundwater infiltration (GWI); Rain Dependent Inflow (RDI); and Rain Dependent Inflow and Infiltration (RDI/I) were based upon observed flow levels as well. Wet weather related flows are generated by the application of the CSO Design Event. The CSO Design Event is defined in *Precipitation and Snowmelt Analyses and Design Event Development for CSO Reduction Alternative Evaluation* Technical Memorandum.

Future BWFs were based upon the City of Spokane's growth management projections for the year 2020. Flows from Spokane County, City of Spokane Valley, City of Airway Heights, and Fairchild Air Force Base were set at the maximum contractual values. Future flows generated by GWI assumed that the reductions stipulated in the City's Wastewater Facility Plan (1999) occur. RDI/I flow from separated areas were based on observed flow levels with exception to the unregulated area tributary to interceptor segment I03 which was assumed to be reduced by 50% before 2017. Wet weather related flows were generated by the application of the CSO Design Event.

The analysis included a review of the existing system conveyance capabilities during dry and wet weather conditions. Simulation results indicated that the majority of the existing interceptor system under current flow levels has sufficient dry weather capacity. However, under wet weather conditions, simulations show that the application of both dry weather loads and the CSO Design Event resulted in significant capacity constraints. These simulations assumed that the CSO regulators restrict the flow to the interceptor to a maximum flow rate.

System Wide Alternative Development

Alternative configurations consisted of first the identification of appropriate CSO technologies and then applying these on a system wide basis. These technologies were narrowed to the following:

- **Separation;** Basin sanitary/ storm sewer separation, discharge to surface water with stormwater treatment
- **Treatment;** Remote CSO treatment discharged to surface waters
- **Partial Separation;** Partial sanitary/ storm separation discharges to treatment bio-swales which eventually is discharged to the ground
- **Storage;** Inline or offline detention storage, off peak interceptor conveyance, treatment (at RPWRF), and discharged to surface waters

It was determined through discussion with Ecology and City staff that use of remote treatment for CSO would be considered only last as a viable option, because of the following:

- Continued CSO discharges with only primary treatment during low river flow conditions.
- Treatment technologies inability to react to large fluctuations in flow.
- Remote treatment's lack of reliability in satisfying water quality.
- Remote treatment O&M requirements uncertainty.
- Future regulations may result in more stringent treatment requirements.

In order to address these uncertainties remote treatment was assumed to satisfy secondary treatment discharge standards.

The technologies were applied to each basin to determine facility size and planning level costs for CSO reduction facilities. These basin specific facilities were then applied to the system and adjusted to achieve the maximum use of existing interceptor and treatment facilities, and satisfy the current regulation.

Before this application, a collaborated workshop between the CSO Project Management Office (PMO) and City staff was conducted to identify system-wide concepts. Twenty-seven concepts were identified. A subsequent workshop expanded these concepts to sixty-six alternatives. This was expanded to sixty-seven to include the preferred alternative of the 1994 CSO Reduction Plan for comparative purposes.

The CSO Design Event was applied to each alternative under 2020 BWF conditions. Capacity, size and location for CSO control facilities were determined. Consistent cost parameters were then applied to each alternative to develop a set of relative costs. Costs include those associated with engineering, property acquisition, construction, construction management, operation and maintenance. A 15% contingency was attached to the construction costs.

A set of Quantitative (Primary) and Qualitative (Secondary) screening criteria were developed for application to identify a set of alternatives for further analysis and evaluation. Quantitative criteria consisted of net present value (NPV) costs and water quality criterion. Qualitative criteria are comprised of functionality O&M, environmental impact, neighborhood acceptability, and constructability.

Initial screening using NPV costs resulted in identification of 10 alternatives. Subsequent application of the remaining screening criteria produced the selection of six alternatives for further analysis. These alternatives are listed as follows:

- 1) **Eastside Advanced Wastewater Treatment Plant**
- 2) **Reroute of Portion of I06 Wet Weather Flows to New I08 Storage**
- 3) **Storage to Provide Interceptor Conveyance Capacity (I02 & I04)**
- 4) **Storage for All CSO Basins except Separate CSO Basin 15 & 41**
- 5) **Reroute Flows from CSO Basins 6, 7, & 10 and from I03 to Provide Interceptor Conveyance Capacity (I02)**
- 6) **Reroute Flows in I08 to RPWRF to Provide Interceptor Conveyance Capacity (I02)**

Evaluation and Selection of the Preferred System Wide Alternative

The six selected alternative system models were constructed. Model storage facilities were configured to more accurately represent actual CSO control facilities at or near feasible site locations. Interceptor inlet controls were refined to better characterize projected performance.

The CSO Design Event was applied to these models in conjunction with 2020 BWF levels to determine CSO reduction facility size and impacts to the interceptor system capacity. Refined and detailed cost parameters were applied to the alternatives resulting in greater accuracy in estimated costs. The alternatives were again subjected to screening criteria. Results yielded two potential preferred alternatives:

- **Alternative 1 - Eastside Advanced Wastewater Treatment Plant**
- **Alternative 2 - Reroute of Portion of I06 Wet Weather Flows to New I08 Storage**

An additional alternative was identified in order to address the uncertainty associated with Alternative 1. This option (Alternative 1) depends on the implementation of a new wet weather/ dry weather wastewater treatment facility. In order to realize the CSO cost advantage for this facility, it also needs to be located at or near the intersection of Interceptor Segments I05 and I07. The feasibility of this treatment facility was being reviewed by local officials from Spokane County, City of Spokane Valley and the City of Spokane. Deliberations included treatment facility locations, treatment capability and operational responsibilities.

Table ES-1 summarizes the application of the screening criteria to the six selected system wide alternatives.

Table ES-1 Summary of Six, Selected System-wide CSO Reduction Alternatives (Wet Weather Costs)

Name	Alternative					
	1	2	3	4	5	6
	Eastside Advanced Wastewater Treatment Plant	Reroute of Portion of I06 Wet Weather Flows to New I08 Storage	Storage to Provide Interceptor Conveyance Capacity (I02 & I04)	Storage for All CSO Basins Except Separate CSO Basins 15 & 41	Reroute Flows from CSO Basins 6, 7, & 10 and from I03 to Provide Interceptor Conveyance Capacity (I02)	Reroute Flows in I08 to RPWRF to Provide Interceptor Conveyance Capacity (I02)
Old ID Number (See Table 3-2)	1.e.ii.	1.d.ii.	1.a.ii.	2.a. + 3.c.	1.b.vi.	1.b.ii.
Total NPV (\$million)	301	314	334	317	324	320
Weighted Score	8.4	6.6	3.6	5.7	4.9	5.1

Through these discussions, a number of configurations to the regional treatment plant were identified. These alternatives proposed a dry weather treatment facility operated by Spokane County which could accept a diversion of flows from Interceptor Segment I07 or CSO Basin 34. For this reason the following variations of Alternative 2 were developed and analyzed:

- **2a □ Reroute of Portion of I06 Wet weather Flows to New I08 Storage**
- **2b | Reroute of Portion of I06 Wet Weather Flows to New I08 Storage**, in conjunction with a constant (no diurnal variations) 2.5 mgd diversion of City flows to a new Spokane County Wastewater Treatment Plant (SCWTP).

The diversion□ source would be flows originating from tributary areas of Interceptor Segment I07. The feasibility of Alternative 2b from a CSO control perspective is dependent upon the future location of the proposed Spokane County Wastewater Treatment Plant (SCWTP). Sites under consideration were the site of the old cattle stockyard (Stockyard Site) and the horse racetrack site (Playfair Site). Spokane County conducted a number of public workshops to review the feasibility of each site and determined that the preferred site was the Stockyard Site. This location increased the cost of the diversion conveyance system significantly. This increased cost has made the diversion impractical economically. Therefore, the preferred CSO system wide alternative selected was Alternative 2, variation 2a. A summary of CSO Reduction Facilities and costs is presented in **Table ES-2**.

The proposed facilities listed were incorporated into a capital improvement schedule to provide a systematic implementation to assure facilities both satisfy the regulation and provide for the timeliness of improvements needed to free capacity for increasing combined sewer diversion to the interceptor system. The schedule also considers the need to afford relatively uniform annual costs. The proposed CSO capital improvement program (CIP) would satisfy the compliance date of 2017. Costs include engineering, construction, construction management and property acquisition. The CIP for Alternative 2a is presented **Table ES-3**.

Included within the preferred alternative proposal is a recommendation to separate the combined systems of CSO Basins 15 and 41. This was determined to be economically feasible and would provide additional interceptor capacity from a system perspective. Both new storm systems were proposed to be constructed and aligned to a singular location for preliminary treatment before discharge to the Spokane River.

Recent regulatory activity concerning the water quality of the Spokane River has caused reconsideration of this particular aspect of the System Wide Alternative 2a. The specific regulatory actions are those related to the Dissolved Oxygen Total Maximum Daily Load (DO TMDL) analyses conducted by Ecology; the issuance by Ecology of the Eastern Washington Stormwater Management Manual (EWSMM); and the future NPDES stormwater discharge permits. These activities imply that stormwater discharges to the Spokane River may require greater treatment than those proposed under the preferred alternative. For this reason the specific recommendations for CSO Basins 15 and 41 are being reviewed. If the results of the reexamination are different than those suggested under the current preferred alternative, this document will be amended through an addenda process.

**Table ES-2 Summary of Sizes and Costs for Required CSO Reduction Facilities Alternative 2a □
Reroute Portion of I06 to I08 Storage (No City Flows to SCWTP)**

Location Description	2003 Regulator Onset of Overflow (threshold) (mgd)	CSO Control	Proposed Flow Control Setting (mgd)	2-year CSO Design Volume (gallon)	Const. Cost Subtotal (2003\$)	Property Cost (2003\$)	Engr. Admin, CM, Contingency (2003\$)	Capital Cost (2003\$)	Annual O&M (2003\$)
Interceptor Conveyance Upgrades	-	-	-	not applicable					
CSO Basin 06-1	1.81	Storage	6.07	2,479,000	\$7,076,000	\$414,000	\$2,830,000	\$10,321,000	\$23,000
CSO Basin 06-2									
CSO Basin 07	1.03	Storage	3.23	163,000	\$815,000	\$10,000	\$326,000	\$1,151,000	\$17,000
CSO Basin 10	0.39	Storage	0.39	217,000	\$1,037,000	\$14,000	\$415,000	\$1,465,000	\$17,000
CSO Basin 12-1	1.07	Storage	6.46	481,000	\$1,942,000	\$30,000	\$777,000	\$2,749,000	\$18,000
CSO Basin 12-2	no outfall	Storage	6.46	602,000	\$2,660,000	\$38,000	\$1,064,000	\$3,762,000	\$18,000
CSO Basin 14	0.90	Storage	0.90	222,000	\$1,056,000	\$28,000	\$422,000	\$1,506,000	\$17,000
CSO Basin 15	-	Separation	-	-	\$2,849,000	\$20,000	\$1,140,000	\$4,009,000	\$29,000
CSO Basin 16-18	2.91	Storage	2.75	316,000	\$1,595,000	\$20,000	\$638,000	\$2,252,000	\$18,000
CSO Basin 19	5.65	Weir Mod.	5.65	-	\$100,000	\$20,000	\$40,000	\$160,000	\$10,000
CSO Basin 20	6.52	Storage	9.69	250,000	\$1,160,000	\$94,000	\$464,000	\$1,717,000	\$18,000
CSO Basin 22b	2.91	Weir Mod.	CSO 25 controlled	-	\$100,000	\$20,000	\$40,000	\$160,000	\$10,000
CSO Basin 23-1	0.95	Storage	0.95	169,000	\$845,000	\$28,000	\$336,000	\$1,211,000	\$17,000
CSO Basin 23-2	no outfall	Storage	0.48	1,353,000	\$4,390,000	\$226,000	\$1,756,000	\$6,372,000	\$20,000
CSO Basin 24 a&b-1	no outfall	Storage	25.84	790,000	\$2,872,000	\$347,000	\$1,149,000	\$4,368,000	\$19,000
CSO Basin 24 a&b-2	9.85	Joint Storage	9.53	5,246,000	\$12,778,000	\$1,644,000	\$5,111,000	\$19,533,000	\$31,000
CSO Basin 25	0.60		0.54						
CSO Basin 26-1	18.15	Storage	32.30	6,684,000	\$17,882,000	\$1,117,000	\$7,153,000	\$26,151,000	\$34,000
CSO Basin 26-2	no outfall	Storage	6.46	391,000	\$2,611,000	\$418,000	\$1,044,000	\$4,073,000	\$18,000
CSO Basin 33a	0.94	Storage	0.94	138,000	\$690,000	\$32,000	\$276,000	\$996,000	\$17,000
CSO Basin 33b	10.00	Storage	9.88	3,863,000	\$10,039,000	\$887,700	\$4,015,000	\$14,942,000	\$27,000
CSO Basin 33c	1.03	Storage	1.03	221,000	\$1,052,000	\$51,000	\$421,000	\$1,524,000	\$17,000
CSO Basin 33d	0.71	Storage	0.58	773,000	\$2,823,000	\$177,000	\$1,129,000	\$4,130,000	\$19,000
CSO Basin 34-1	10.50	Storage	1.94	2,796,000	\$9,829,000	\$584,000	\$3,932,000	\$14,345,000	\$24,000
CSO Basin 34-2	no outfall	Storage	6.46	1,322,000	\$4,310,000	\$276,000	\$1,724,000	\$6,311,000	\$20,000
CSO Basin 34-3	no outfall	Storage	25.84	7,075,000	\$16,176,000	\$1,478,000	\$6,470,000	\$24,124,000	\$35,000
CSO Basin 34-4	no outfall	Storage	129.20	1,396,000	\$4,500,000	\$292,000	\$1,800,000	\$6,591,000	\$21,000
CSO Basin 34-5	no outfall	Storage	12.92	586,000	\$2,270,000	\$122,000	\$908,000	\$3,299,000	\$18,000
CSO Basin 34-6	no outfall	Storage	28.42	2,440,000	\$6,988,000	\$510,000	\$2,795,000	\$10,293,000	\$23,000
CSO Basin 38, 39, 40	.39, .45, .39	Storage	4.52	416,000	\$1,732,000	\$183,000	\$693,000	\$2,608,000	\$18,000
CSO Basin 41	-	Separation	-	-	\$2,380,000	\$20,000	\$952,000	\$3,352,000	\$27,000
CSO Basin 42	1.39	Storage	1.39	140,000	\$700,000	\$29,000	\$280,000	\$1,009,000	\$17,000
Interceptor 3-1	no outfall	Storage	6.46	279,000	\$1,264,000	\$29,000	\$506,000	\$1,799,000	\$18,000
Interceptor 3-2	no outfall	Storage	12.92	759,000	\$2,783,000	\$80,000	\$1,113,000	\$3,976,000	\$19,000
Interceptor 4-1	no outfall	Storage	5.49	3,375,000	\$9,025,000	\$353,000	\$3,610,000	\$12,987,000	\$26,000
Interceptor 4-2	no outfall	Storage	0.97	221,000	\$1,052,000	\$23,000	\$421,000	\$1,496,000	\$17,000
Post Street	no outfall	Storage	1.29	204,000	\$988,000	\$219,000	\$395,000	\$1,602,000	\$17,000
Eastside WTP	-	-	-	-					
RPWRF	no outfall	Storage	100.00	12,943,000	\$26,082,000	\$0	\$10,433,000	\$36,514,000	\$51,000
RPWRF Wet Treatment (O&M)	-	add'l flow	-						
TOTAL				58,310,000	166,451,000	9,834,000	66,580,000	242,860,000	1,212,000

Table ES-3 CIP for Alternative 2a

Description	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CSO Basin 16&18			0.18	2.07											
CSO Basin 19			0.03	0.13											
CSO Basin 22b				0.03	0.13										
CSO Basin 41				0.07	0.19	3.09									
CSO Basin 15					0.09	0.22	3.70								
CSO Basin 14					0.03	0.10	1.37								
CSO Basin 42			0.02	0.08	0.91										
CSO Basin 10			0.03	0.09	1.35										
Interceptor I03-1					0.04	0.12	1.64								
Interceptor I03-2						0.08	0.27	3.62							
CSO Basin 06-1						0.21	0.91	5.13	4.07						
CSO Basin 07								0.02	0.07	1.06					
CSO Basin 12-1							0.06	0.17	2.53						
CSO Basin 12-2									0.08	0.22	3.46				
CSO Basins 38, 39& 40									0.05	0.30	2.25				
Interceptor I04-1								0.27	0.98	6.54	5.19				
Interceptor I04-2								0.03	0.10	1.37					
Post Street								0.03	0.29	1.28					
CSO Basin 23-1						0.03	0.09	1.10							
CSO Basin 23-2							0.13	0.53	5.71						
CSO Basin 26-1										0.54	0.56	1.81	5.81	8.72	8.72
CSO Basin 26-2												0.08	0.60	3.39	
CSO Basin 24 a&b-1										0.09	0.55	3.73			
CSO Basin 24 a&b-2								0.38	0.55	0.55	0.55	0.89	4.15	6.23	6.23
CSO Basin 20									0.03	0.18	1.51				
CSO Basin 33a					0.02	0.08	0.90								
CSO Basin 33b						0.30	0.70	0.44	0.44	6.53	6.53				
CSO Basin 33c						0.03	0.07	0.05	1.37						
CSO Basin 33d						0.08	0.20	0.18	3.67						
CSO Basin 34-1										0.29	1.27	6.39	6.39		
CSO Basin 34-2									0.13	0.30	0.28	5.60			
CSO Basin 34-3									0.49	0.49	0.49	1.62	5.26	7.89	7.89
CSO Basin 34-4												0.13	0.31	0.29	5.85
CSO Basin 34-5											0.07	0.28	2.95		
CSO Basin 34-6											0.21	1.00	4.54	4.54	
SAWTP											0.78	1.83	8.48	12.71	12.71
Total (million \$)			0.26	2.47	2.75	4.35	10.05	11.96	20.55	19.74	23.69	23.38	38.50	43.78	41.40

Note: CSO Basin 06-1 includes the cost associated with 06-2. CSO Basin 25 costs are included in CSO Basin 24.

Chapter 1: Introduction

This document provides an overview of the development, screening, and recommendation of the preferred system-wide alternative for combined sewer overflow (CSO) reduction for the City of Spokane (City). All alternatives for CSO reduction were intended to provide sufficient CSO reduction for compliance with State of Washington regulations, Chapter 173-245 WAC. This report and its recommended system-wide alternative amend or replace the City's Combined Sewer Overflow Reduction Plan dated January, 1994 and the preferred alternative specified therein. A flow chart depicting the process used is presented in **Figure 1-1**.

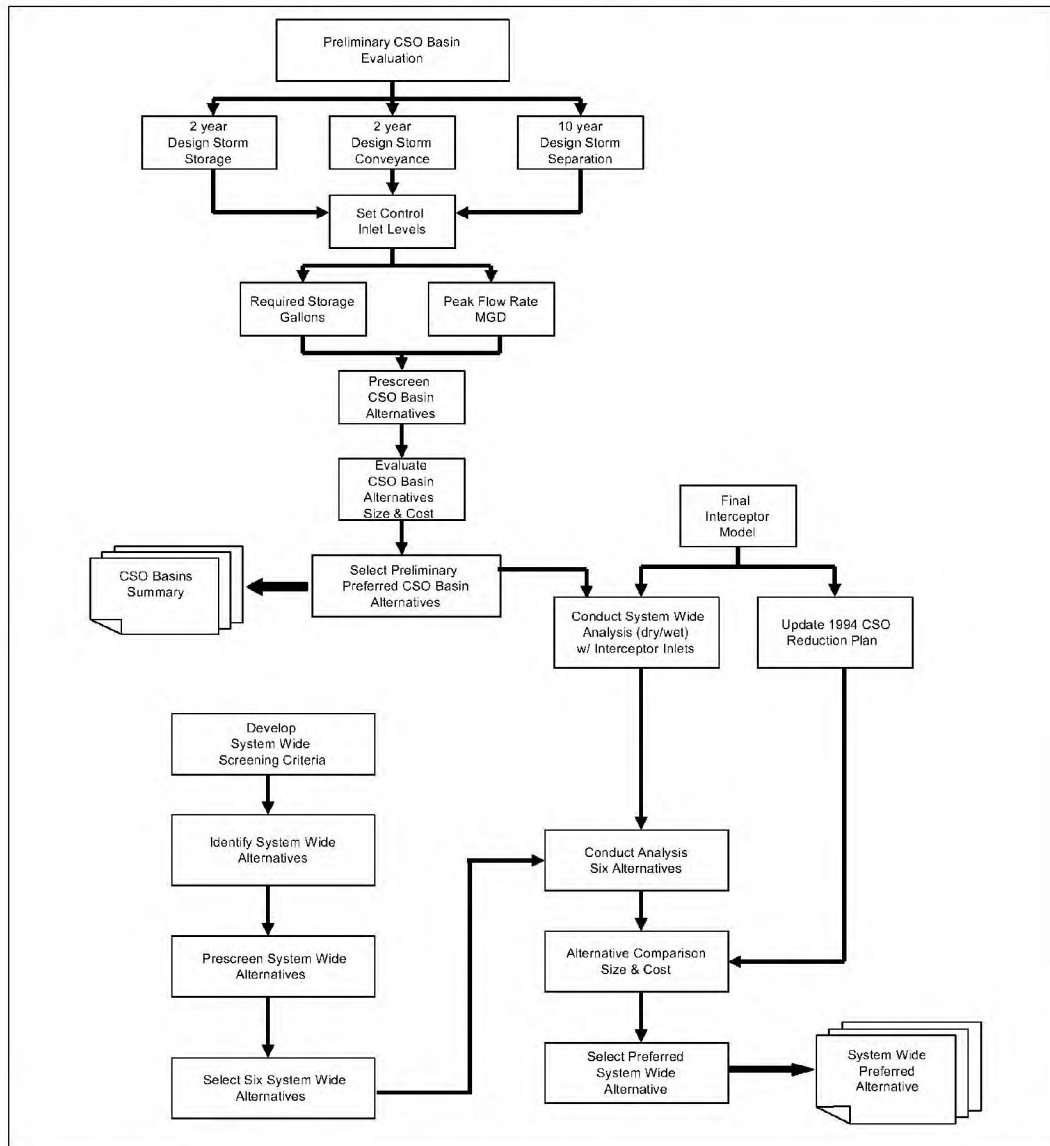


Figure 1-1 System Wide Alternative Process

This chapter provides an overview of flow rates in the relevant components of the combined sewer system (CSS) and the interceptor system for baseline (2001) and future (2020) flow conditions, as specifically defined below.

Later chapters provide the following:

- Chapter 2. Basis and definition of a set of system-wide CSO reduction concepts, which were identified through a collaborative process, and expansion of these concepts into a broad set of alternatives.
- Chapter 3. Development and description of the application of screening criteria to provide a basis for selecting a select set of alternatives and then selection of the preferred alternative.
- Chapter 4. Application of screening criteria to the broad set of alternatives to reduce them systematically to a selected set of alternatives.
- Chapter 5. Evaluation of a selected set of alternatives.
- Chapter 6. Recommendation of a preferred system-wide alternative.

1.1 Interceptor and System-wide CSS Flow Rate Scenarios

In order to determine CSO reduction and interceptor conveyance needs for the various alternatives identified and developed for the CSO program, the following flow rate scenarios were simulated via an XP-SWMM computer model:

- 1) 2001 □Dry Weather under Existing Conditions
- 2) 2001 □Wet Weather under Existing Conditions
- 3) 2020 □Dry Weather without Spokane County Wastewater Treatment Plant (SCWTP)
- 4) 2020 □Wet Weather without SCWTP
- 5) 2020 □Dry Weather with SCWTP
- 6) 2020 □Wet Weather with SCWTP

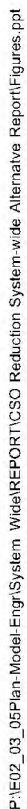
The □SCWTP□ refers to a proposed wastewater treatment plant located in the eastern portion of the City of Spokane or western portion of the City of Spokane Valley. Outside of the City's CSO program, various alternatives for siting, sizing, and governing this wastewater treatment plant have been studied.

The interceptor was analyzed for capacity utilizing Scenarios 1 and 2 (2001) and Scenarios 5 and 6) (2020). Baseline CSO frequency and volume simulations utilized a typical rainfall year applied to 2003 flow rates. CSO regulation compliance needs were determined utilizing Scenario 6 (although some initial simulations utilized Scenario 5).

In this analysis, the □Wet Weather□ flow rate scenarios correspond to the application of the approved CSO Design Event as defined in the Technical Memorandum: *Precipitation and Snowmelt Analyses and CSO Design Event Development for CSO Reduction Alternative Evaluation* (CTE Engineers, Feb 2002).

1.2 Collection System Flow Rate Components

The City's CSO basins (and major interceptors) are shown in **Figure 1-2**.



The City has separate system definitions for their collection system and interceptor system. The definitions for the collection system are cited herein. The assumptions and basis for the components of Collection System flow rates □ base wastewater flow, groundwater infiltration, rainfall dependent inflow and infiltration, storm water runoff, and snow melt are discussed below.

The City of Spokane is the only agency that owns or operates combined sewer systems in the region. Other areas that are served by other agencies do exhibit wet weather influences, even if they are only seasonal impacts, but these impacts are discussed under Interceptor flow rate components.

1.2.1 Base Wastewater Flow (BWF)

Base Wastewater Flow (BWF) is defined as follows:

| Base Wastewater Flow is the sanitary and process wastewater flow originating from residential, commercial, institutional, and industrial sources. |

Additional definitions, and applications to this CSO program, include:

- **Average Base Wastewater Flow:** The Average Base Wastewater Flow is the proportional distribution of Base Wastewater Flow within a specified period of time. In the CSO program, this is considered to be the annual average applied on a daily basis, i.e., averaging the entire year's BWF over 365 days. For the City's collection system, BWF originates from both separated and combined sewer systems within the City's service area. The BWF rates for the City's CSS are listed in **Table 1-1** for each of the six flow scenarios identified above.

Table 1-1 Summary of CSSs Base Wastewater Flow (BWF)

Source	Annual Average BWF (mgd) ¹	
	Scenario 1 & 2 2001	Scenario 3, 4, 5 & 6 2020
CSO Basin 02	0.05	0.06
CSO Basin 03B	0.33	0.37
CSO Basin 03C	0.11	0.13
CSO Basin 06	0.36	0.41
CSO Basin 07	0.17	0.19
CSO Basin 10	0.06	0.07
CSO Basin 12	0.31	0.36
CSO Basin 14	0.13	0.15
CSO Basin 15	0.12	0.14
CSO Basin 16A, 16B & 18	0.28	1.03
CSO Basin 19	0.01	1.87
CSO Basin 20	0.17	0.10
CSO Basin 22B	1.63	0.15
CSO Basin 23	0.08	1.37
CSO Basin 24A	0.10	0.11
CSO Basin 24B	1.12	0.74
CSO Basin 25	0.09	0.11
CSO Basin 26	0.68	0.06
CSO Basin 33A	0.08	5.83
CSO Basin 33B	0.04	0.10
CSO Basin 33C	3.48	0.06
CSO Basin 33D	0.09	0.07
CSO Basin 34	0.05	0.10
CSO Basin 38	0.06	0.24
CSO Basin 39	0.09	0.06
CSO Basin 40	0.22	0.37
CSO Basin 41	0.05	0.06
CSO Basin 42	0.33	0.37
CSSs (total)	10.22	14.33

1) Flow projections based upon City of Spokane growth management act (GMA) forecasts.

- The City's wastewater service area is 57,500 acres and contains a service population of approximately 200,000 (97% reside within city limits). The City's wastewater collection system has over 840 miles of sewer pipes, 14 inverted siphons (sag pipes), and 27 publicly owned sewage lift stations. The sewer lines include separate sanitary and stormwater sewers and combined sewers. Combined sewers make up 48% of the collection system, followed by 35% sanitary, and 15% stormwater pipes. Stormwater is collected and discharged through approximately 14,000 catch basins/ dry wells and to local surface waters through approximately 80 stormwater outfall pipes. Sanitary sewage and most of the combined wastewater is collected and routed to the Riverside Park Water Reclamation Facility (RPWRF). There are 28 CSO regulators that discharge excess combined sewage through 23 outfall pipes during wet weather (Source City of Spokane Wastewater Facility Plan, November 1999).
- Peak Base Wastewater Flow: Peak Base Wastewater Flow is the highest Base Wastewater Flow along the diurnal curve. The expected or projected Peak Wastewater Flow is estimated and applied through the use of peaking factors applied to the Average Base Wastewater Flow. In the CSO program, diurnal BWF variations are expected, which are described in the next bullet. No seasonal variation in BWF is expected, where it is assumed that BWF generation and daily use patterns remain nearly constant throughout the year no significant peak month, peak week, or peak day BWF rate variations. Such flow variability is expected to come from other sources of infiltration or inflow that are seasonal or precipitation event-driven, as defined and described in later subsections.
- Diurnal Temporal Correction Factors: In the CSO program, adjustment factors are applied to model load points on an hourly basis, with each day of the week having a unique set of hourly, diurnal temporal correction factors. These factors were developed based on flow monitoring and calibration, as presented in the memorandum Combined Sewer System Model Inputs and Calibration; Section 2.3.1.1 (CTE Engineers, April 2002). The diurnal temporal correction factors vary from 0.22 to 2.67 diurnally (over any given day) and from 0.86 to 1.17 throughout the week (for each day of the week). As mentioned above, no seasonal variations in BWF are expected; therefore, a single set of diurnal temporal correction factors were determined.
- Peaking Factors: Peaking Factors for the collection system are defined in Section 3.4.2 [City of Spokane Wastewater Facility Plan, 1999] and applied as described in Section 3.5 Collection System Analysis [City of Spokane Wastewater Facility Plan, 1999].

1.2.2 Groundwater Infiltration (GWI)

Groundwater infiltration (GWI) for the City's collection system is defined as follows:

Groundwater infiltration is the groundwater entering the collection system through aging or defective pipes, pipe joints, and manhole walls. Groundwater Infiltration flow for the collection system is defined in Section 3.4.3 [City of Spokane Wastewater Facility Plan, 1999].

Simulation of groundwater infiltration is represented in the current modeling by two values, as follows:

- 1) Average GWI rate. Average GWI rates were determined for individual CSO basins during the calibration process to match the actual, monitored dry weather flow rates.
- 2) Excess GWI rate. Excess GWI rates were applied, on a site-specific basis, to CSO basins that exhibited high, monitored dry weather flow rates. To address these excessive GWI flow rates, the City's Wastewater Facilities Plan (section 3.8.2) identifies a set of infiltration and inflow (I&I) reduction projects.

The GWI for the City's collection system is summarized in **Table 1-2**, as taken from the draft Memorandum *Preliminary Interceptor Capacity Analysis for CSO* (CTE Engineers, November 2002). The City's Wastewater Facilities Plan indicates that a factor of 2 should be applied to GWI to

determine a Peak Dry Weather Flow for the collection system including combined sewers. For this analysis a safety factor of 1.5 has been chosen and has been applied to all calibrated GWI. This is based upon observed fluctuations in GWI during wet seasons potentially attributed to the rise of groundwater tables due to prolonged rainfall percolating into the ground. The 1.5 safety factor is considered reasonable and conservative. Initial calibration of the CSO basin models utilized data from the intensive flow monitoring period of April 2001 to August 2002, which was a relatively dry period for the region. Subsequent refinement of the initial calibration is ongoing. These flow monitoring data have not provided any evidence that this safety factor value should be modified.

The GWI listed in **Table 1-2** for the interceptors system's components is GWI coming from the City's collection system tributary to the respective interceptor component. This contribution of GWI from interceptors is further classified in Section 1.3, below.

In addition, the Northside Landfill leachate is not included in any current analyses (it was included in the 1994 Plan) because this leachate has been physically disconnected from the City's sewer system in the summer of 2001 (City Staff 2001).

Table 1-2 Summary of Collection System Groundwater Infiltration (GWI)

Source	GWI (mgd)			
	Scenario 1 & 2 (2001)		Scenario 3, 4, 5, & 6 (2020)	
	Annual Average	Seasonal Peak	Annual Average	Seasonal Peak
CSO Basin 02	0.011	0.016	0.011	0.016
CSO Basin 03B	0	0	0	0
CSO Basin 03C	0	0	0	0
CSO Basin 06	0	0	0	0
CSO Basin 07	0	0	0	0
CSO Basin 10	0	0	0	0
CSO Basin 12	0	0	0	0
CSO Basin 14	0	0	0	0
CSO Basin 15	0	0	0	0
CSO Basin 16A	0.067	0.101	0.067	0.101
CSO Basin 16B	0.281	0.422	0.281	0.422
CSO Basin 18	0	0	0	0
CSO Basin 19	0	0	0	0
CSO Basin 20	0.039	0.059	0.039	0.059
CSO Basin 22B	0	0	0	0
CSO Basin 23	0	0	0	0
CSO Basin 24A	1.447	2.171	1.447	2.171
CSO Basin 24B	0.088	0.132	0.088	0.132
CSO Basin 25	0	0	0	0
CSO Basin 26	3.321	4.981	1.734	2.601
CSO Basin 33A	0.032	0.048	0.032	0.048
CSO Basin 33B	1.576	2.364	1.423	2.134
CSO Basin 33C	0	0	0	0
CSO Basin 33D	0.207	0.310	0.207	0.310
CSO Basin 34	1.085	1.628	1.085	1.628
CSO Basin 38	0	0	0	0
CSO Basin 39	0	0	0	0
CSO Basin 40	0	0	0	0
CSO Basin 41	0	0	0	0
CSO Basin 42	0	0	0	0
I01	0.275	0.412	0.275	0.412
I02	0	0	0	0
I03	0.173	0.260	0.173	0.260
I04	0.239	0.359	0.239	0.359
I05 Lower	0	0	0	0
I05 Upper	0.028	0.042	0.028	0.042
I06 - Included in CSO Basin 26	0	0	0	0
I07	0.420	0.630	0.420	0.630
I08	0.033	0.050	0	0
City (total)	9.322	13.985	7.549	11.325

1.2.3 Rainfall Dependent Inflow and Infiltration (RDI&I)

Rainfall Dependent Inflow and Infiltration (RDI&I) is defined as follows:

□Rainfall Dependent Inflow and Infiltration is storm water that enter[s] separate sanitary sewers in direct response to rainfall. It consists of both storm water inflow from connections into the sewers and rainfall dependent infiltration into pipe and manhole defects. □

Currently, considerable RDI&I have been observed from unregulated area sources (Post Street Bypass, Interceptor Segment I03, and Interceptor Segment I04). The City is addressing the RDI&I in the I03 service area under a separate project. In this CSO program, it has been assumed that 50% of current RDI&I for the I03 service area, will be eliminated under the design scenario. RDI&I flow rates are summarized in **Table 1-3**. The data presented in **Table 1-3** are based on the application of the CSO Design Event, while following all other modeling approaches as specified herein for the CSO Program Management Office (PMO).

Table 1-3 Summary of Collection System Rainfall Dependent Inflow and Infiltration (RDI&I)

Source	RDI&I (mgd)	
	2001	2020
Post Street Bypass	8	8
I03	27	19
I04	37	37

1.2.4 Storm Water Runoff (SWR)

Storm Water Runoff (SWR) is defined as follows:

□Storm Water Runoff is the surface runoff which enters combined sewers during and immediately following rainfall events. The runoff is conveyed through the combined sewer system(s) to a combined sewer regulator. The regulator route flow to the interceptor or directs excess flow to the Spokane River [or Latah Creek]. □

In the CSO program, SWR is specifically expected in the 23 CSO basins (23 outfalls & 28 regulators) and is applied under a CSO Design Event that consists of both rainfall and snow melt. This CSO Design Event is defined in the Technical Memorandum: *Precipitation and Snowmelt Analyses and CSO Design Event Development for CSO Reduction Alternative Evaluation* (CTE Engineers, Feb 2002). Simulated values of SWR are presented and discussed later in this report.

1.2.5 Snow Melt

Snow Melt is defined as follows:

□Snow Melt is surface runoff which enters combined sewers during and immediately following snow fall events [or during subsequent melting periods]. The runoff is conveyed through the combined sewer system(s) to a combined sewer regulator. The regulator route flow to the interceptor or directs excess flow to the Spokane River [or Latah Creek]. □

In this CSO program, Snow Melt has been included in the approved CSO Design Event as defined in the Technical Memorandum: *Precipitation and Snowmelt Analyses and CSO Design Event Development for CSO Reduction Alternative Evaluation* (CTE Engineers, Feb 2002). Simulated values of Snow Melt are presented and discussed later in this report.

1.2.6 River Inflow

Although not specifically defined in the City's Wastewater Facilities Plan, River Inflow is the flow that enters the sewer system through similar defects as stated under GWI, but originates specifically from the river due to river stage. River Inflow is further discussed below under Interceptor flow rate components.

1.3 Interceptor System Flow Rate Components

The assumptions and basis for the components of Interceptor system flow rates — base wastewater flow, groundwater infiltration, rain dependent flow, and river inflow are discussed below.

As noted previously, the City's CSO basins and major interceptors are shown in **Figure 1-2**.

1.3.1 Base Wastewater Flow (BWF)

For the interceptor system, including flows being generated outside of the City's service area or incorporated boundary (but are conveyed through the interceptor system to RPWRF), BWF is defined similarly as given previously for the collection system flow rate components.

Currently, for the City of Spokane interceptor system, BWF to the collection system originates from within the City's service area including both the CSSs and separated areas and from areas outside of the service area, such as Spokane County, City of Spokane Valley, Town of Millwood, Fairchild Air Force Base, and City of Airway Heights. The annual average BWF totals for these other areas are listed in **Table 1-4** for each of the six flow scenarios identified previously. Spokane County flows are represented by tributary areas to North Spokane Interceptor (NSI), North Valley Interceptor (NVI), and Spokane Valley Interceptor (SVI). Flows from these sources do not exceed the contractual limits.

Table 1-4 Summary of Interceptor Base Wastewater Flow (BWF)

Source	Annual Average BWF (mgd)		
	Scenario 1 & 2	Scenario 3 & 4	Scenario 5 & 6
NSI ⁽¹⁾	1.8	2.0	4.7
NVI ⁽¹⁾	1.9	6.5	0
SVI ⁽¹⁾	6.0	9.5	5.3
Chronicle ⁽¹⁾	0.3	0.3	0.3
Airway Heights ⁽²⁾	7 0.	0.7	0.7
Fairchild AFB ⁽²⁾	9 0.	0.9	0.9
I08 Total ⁽²⁾	3.5	3.5	3.5

Notes:

(1) Flow rates are based on Spokane County Wastewater Facilities Plan Basis of Planning Report, Dec. 2000.

(2) Flow rates are based on May 2001 letter and meter records for Airway Heights (0.39 mgd annual average for 2001) and Fairchild Air Force Base (0.64 mgd annual average for 2001).

Spokane County Wastewater Facilities Plan (Final, December 2002) shows NSI to have 4.9 mgd (annual average, with a peak hour of 10.0 mgd) under all 2025 scenarios (4.7 mgd is reasonable for 2020).

Diurnal Temporal Correction Factors: Similar to the City's collection system, unique hourly and daily (for each day of the week) diurnal temporal correction factors were determined for model load points representing areas outside the City's service area (i.e. NVI, SVI etc.). These were to reflect the total impact of flow rates generated by the unincorporated areas of Spokane County, Town of Millwood, City of Airway Heights, Fairchild Air Force Base and City of Spokane Valley. Again, these diurnal temporal correction factors were developed from flow monitoring and calibration, as presented in the memorandum *Combined Sewer System Model Inputs and Calibration* (CTE Engineers, April 2002) *Sewer System Model Inputs and Sewer System Model Inputs and Calibration* (CTE Engineers, April 2002).

1.3.2 Groundwater Infiltration

For the interceptor system, including flows being generated outside of the City's service area or incorporated boundary (but are conveyed through the interceptor system to RPWRF), GWI is defined similarly as given previously under the collection system flow rate components.

Interceptor GWI originates in the collection system of the City of Spokane, and is derived as a summation of the GWI inputs from the various collection system loads. GWI specific to the interceptor system was not identified because the interceptor has not exhibited a GWI component and a significant portion of the interceptor system lies above the groundwater table. Although some GWI may exist in the interceptor system, it is expected to be negligible in comparison to either the collection system GWI or total wet weather flow rates. This total GWI generated in the collection system areas contributing to the City's interceptor system is given in **Table 1-2** for each of the six flow scenarios identified above.

Areas served by Spokane County and the City of Airway Heights where the majority of the collection systems tributary to the City's Interceptor System, were built to modern standards, are not expected to have significant GWI. Specifically, areas served by Spokane County, GWI has been estimated as just less than 10% of the BWF for these areas, where Spokane County defines a Maximum Month flow rate, which is approximately 10% greater than the annual average BWF to account for GWI and seasonal variability on GWI and RDI/I. This is presented in the Spokane County Wastewater Facilities Plan Amendment Volume I, February 2003. It should be noted that the flow rates from the County to RPWRF are limited to a contractual flow rate limit of 10 mgd annual average and 15 mgd peak hour. Flows that exceed these rates are assumed to be diverted to the new Spokane County Wastewater Treatment Plant. Older collection systems such as Fairchild Air Force Base and the Town of Millwood are assumed to have GWI + BWF maintained at contractual levels.

1.3.3 Rainfall Dependent Flow

Rainfall Dependent Flow is defined as follows:

□Rainfall Dependent Flow is storm water that enters the interceptor system in direct response to rainfall. It is generated by the collection system and consists of collection system RDI&I, Storm Water Runoff, and Snow Melt. Storm Water Runoff and Snow Melt enter the interceptor through a CSO Regulator. The Regulator routes excess flows to the Spokane River [and Latah Creek].

For City's CSO program, the interceptor has been calibrated and the results of this calibration show that the flow rates entering the interceptor system are the summation of the collection system flow rates, including BWF, GWI, RDI&I, SWR, and Snow Melt from the contributing collection system. All Rainfall Dependent Flow was shown to be generated in, or contributed by, the collection system.

1.3.4 River Inflow

Although not specifically defined in the City's Wastewater Facilities Plan, River Inflow is the flow that enters the sewer system through similar defects as stated under GWI, but originates specifically from the river due to river stage. The City has initiated actions to address river inflow and is in the process of finalizing a plan to substantially reduce river inflows by the year 2017.

Historically, considerable River Inflow occurred through the outfall from CSO Basin 33; however, in 1999 a tideflex, backflow prevention valve was installed on the discharge end of the outfall. In addition, a similar backflow prevention device was placed on the outfall from CSO Basin 22b in 1996.

River Inflow has been detected to occur in the following interceptor segments at specific sites, as given in the Technical Memorandum *Assessment of Spokane River Inflow to City of Spokane Interceptors* (CTE Engineers, August 2004):

- I04 and Downstream. Some river inflow has been surmised to occur in Interceptor Segment I04, but could not be confirmed. No inflow has been detected downstream of I04. Although some inflow was measured in I04, the flow monitoring was not consistent; therefore, correlation with river discharge or identification of an inflow site could not be determined. Flow monitoring data has indicated that a potential peak daily inflow of approximately 8.0 million gallons could occur from I04.
- I05 Lower and I07. No obvious inflow has been detected for I05 Lower, while inflow has been measured in I07 and occurs for river discharges exceeding approximately 15,000 cubic feet per second (cfs) and a stage of 1887 feet at the USGS River Gage 12422500. The most likely portion of I07 that is implicated in this inflow is in the vicinity of Manhole 5902124 located at the intersection of Front Avenue and Helena Street.

The annual volume of river inflow extrapolated from flow monitoring records in Interceptor Segment I07 is predicted to range from an average of 100 to 180 million gallons to a maximum of 700 million gallons. Daily peak flow rates ranged from an average of 3.5 to 5.5 million gallons per day to a potential maximum of 13 million gallons per day.

- I05 Upper. Inflow associated with Interceptor Segment I05 Upper has been measured in the Trent and Mallon basins and occurs when river flow rates exceed approximately 15,000 cfs with a corresponding stage of 1887 feet (NAV 88) at the USGS River Gage 12422500. The most likely portion of the Trent basin that is implicated in this inflow is in the vicinity of Manhole 5800220 (Trent Avenue and Denver Street) and Mallon Basin is Manhole 5802924 (Mallon Avenue and Perry Street).

The annual volume of inflow extrapolated from flow monitoring records in Interceptor Segment I07 is predicted to range from an average of 100 to 160 million gallons to a maximum of 900 million gallons. Daily peak flow rates ranged from an average of 4.0 to 7.0 million gallons per day to a potential maximum of 22 million gallons per day.

- Upstream of I05 Upper. Inflow associated with upstream of I05 Upper has been measured at the Greene Street bridge flow monitor; however, no focused flow monitoring was available upstream of this monitor site to isolate the source of this inflow. The flow monitoring data indicated that a peak daily inflow of approximately 3.0 million gallons per day occurred upstream of the Greene Street bridge flow monitor.

No other areas of the interceptor were evaluated because the Spokane River water surface elevation lies well below the inverts of the interceptor piping. In addition, River Inflow in the form of a distributed inflow through pipe defects was not detected or discovered.

As a result of the River Inflow memorandum, identified sources (pipes and manholes) were sealed to reduce river inflow. Specifically at locations near Spokane Falls Boulevard and Howard Street, the Springfield Avenue pump station, and near Sharp Avenue and Perry Street access. Manhole access lids have been replaced with sealed lids along South Riverton between Mission Avenue and Regal Street which are subject to inflow influence from high river flows.

Generally, the City's approach to river inflow elimination is to identify seal, repair or replace inflow source pipe segments or manholes. These sources are located through flow monitoring at select points within the system (identified generally in the River Inflow memorandum) both during low and high river level periods. In addition, manual flow depth readings and daily river stage recordings are used to develop trends of high river level influence on the collection system.

For purposes of this analysis, it has been assumed that each of the River Inflow sources will be removed or eliminated by the CSO compliance date of 2017. Specific recommendations to address these sources are provided in the *Assessment of Spokane River Inflow to City of Spokane Interceptors* (CTE Engineers, August 2004).

1.4 Sewer System Simulation Approach

Portions of the collection system and interceptor systems were modeled as presented in this subsection. The CSO PMO utilizes the XP-SWMM model.

1.4.1 Collection and Interceptor System

The following assumptions and conditions were applied to the collection and interceptor system during all simulations:

1. Flow capacities are determined using Manning's equation with a constant roughness factor n of 0.013. Pipe segments constructed of corrugated metal use and n factor of 0.029. The XP SWMM model platform does not currently support the use of variable n . Generally, use of variable n results in a greater depth to diameter pipe ratio or less pipe capacity. However, as the flow rate approaches full pipe (depth/diameter = 1) the variable n factor \approx constant n (0.013). For purposes of this analysis use of constant n will not affect the resultant analytical flow rates which are near or at full depth flow.
2. Pump stations that were determined to have direct or significant influence on downstream segments of the collection or interceptor system being modeled were simulated dynamically including on/off pumping based on wet well volumes (Clark Street, San Souci, Elm Street, Northwest Terrace, Marion Hay (Spokane County), and Francis & Cannon). Other pump stations are located in separated areas or in the upper portions of the collection system and were modeled as part of the flow load based on the overall land area in which the pump station is located.
3. Inverted siphons were simulated as equivalent pipe segments in order to reduce computer run time, without significantly affecting accuracy. Equivalent pipes were limited to a maximum flow velocity of 10 ft/sec.
4. No sedimentation or blockages in any pipes.
5. The interceptor has a peak conveyance flow rate at the headworks of the treatment plant of 130 mgd. The treatment plant peak flow rate which can provide full treatment is restricted to 100 mgd. Flow rates in excess of 100 mgd are diverted to detention storage for subsequent full treatment or at least wet weather treatment before discharge to the Spokane River.

1.4.2 Design Loads

1.4.2.1 Base Wastewater Flows

The following assumptions regarding modeling of the collection and interceptor systems were applied during simulations:

1. Projected wastewater flows are based upon growth management projections to the year 2020.
2. Any flow rates that exceed the contractual flow rates to the interceptor system are assumed to be diverted to the Spokane County Wastewater Treatment Plant and not included in the flow loads to the City's interceptor system in any model simulation or analysis.

1.4.2.2 Groundwater Infiltration

The following ground water infiltration (GWI) conditions apply to the collection system for the various dry weather flow simulations:

1. GWI in areas served by the County that are conveyed to the City's interceptor sewer system is included within a 10% adjustment over BWF for those areas.
2. GWI in areas served by the Airway Heights is not considered to exist or be significant due to the relatively young age of their collection system.
3. GWI in areas served by the Fairchild Air Force Base are expected to be eliminated by the CSO compliance date (2017).

4. River Inflow, for specific areas that have been identified, is assumed to be eliminated by the CSO compliance date (2017).

1.4.2.3 Rain Dependent Inflow and Infiltration

The following Rain Dependent Inflow and Infiltration (RDI&I) conditions apply to the collection system for the various wet weather flow simulations:

1. County flows include seasonal RDI&I and are incorporated in the 10% adjustment to BWF. No other areas served by other agencies that are conveyed to City's interceptor sewer system are assumed to have RDI&I.
2. RDI&I in sanitary or separated areas of the City's sewer system was included as calibrated, except for the Interceptor Segment I03 (Cochran Basin), whose RDI&I is assumed to be reduced by 50% based on a presumptive success rate for current I&I reduction activities in the I03 tributary areas. Snowmelt conditions in separate sanitary basins were not included.
3. Wet Weather Design Loads
4. The following loads and conditions were applied to the collection and interceptor system during wet weather simulations:
5. The CSO Design Event includes a rainfall and snowmelt condition. The rainfall for all collection system areas that demonstrate a response to wet weather including the CSO basins and the previously separated areas served by I03, I04, and the Post Street Bypass sewer is: a system-wide, 2-year return frequency of 24 hour duration; depth of rain is spatially adjusted system wide for each CSO basin; rain distributed by an SCS Type II distribution as given in Precipitation and Snowmelt Analyses and Design Event Development for CSO Reduction Alternative Evaluation (CTE Engineers, February 2002). The rainfall peak is simulated to occur at 12:00 noon. The snowmelt condition for the same areas on which the design event rainfall is applied (in addition to rainfall) is a 1/2-year return frequency consisting of 2 inches of depth (0.374 in water equivalent) melting over a 24 hour period.
6. The XP SWMM infiltration parameter initial moisture content was set at 0.1 wet antecedent moisture conditions for runoff areas.
7. The XP SWMM evaporation parameter was assigned to have minimal evaporation based on simulated data for January 1, 2001 (above freezing temperature) for runoff areas.
8. CSO Regulators are set to flat line performance at the existing threshold as observed in the flow monitoring data (where "threshold" is defined as the flow rate value in the combined trunk inlet at which the initial onset of overflow to the CSO outfall occurs). Flat line performance is defined as the maximum flow that can be conveyed to the interceptor. As the flow rate to the CSO regulator reaches or exceeds the specified threshold flow rate, the flow rate conveyed to the interceptor is held constant, and set at the threshold value. This simulated performance results in the maximum predicted overflow volume. In absence of new data, the threshold setting defaults to the threshold value given in the 1994 Plan,

1.5 Interceptor Capacity

The capacity of the existing City interceptor system to convey dry and wet weather flows has been analyzed through model simulations. This interceptor capacity analysis is presented in detail in the draft Memorandum *Preliminary Interceptor Capacity Analysis for CSO* (CTE Engineers, June 2004). A summary of this capacity analysis is presented herein. Flows are defined for both existing conditions (Scenario 1&2) and four future conditions (Scenarios 3, 4, 5, & 6). Future flow conditions do not include any CSO reduction efforts and their associated impact. The results of these analyses are provided in the referenced report.

The simulation results are conservatively based on full pipe flow capacity. It has been shown (Chow, 1959) that the maximum flow capacity of pipes actually occurs at slightly less than full pipe conditions.

In addition, the wet weather simulations include the uniform application of the CSO Design Event across the entire service area simultaneously. The CSO Design Event is representative of an SCS Type II storm distribution coupled with a coincidental snow melt condition (CTE Engineers, Feb 2002).

The interceptor system inlet flow control structures consist of mostly leaping weirs and side dams, which have been determined to not provide consistent inlet flow rates to the interceptor necessary to provide a predictable level of flow control in the interceptor system. The proposed improvements identified in the CSO reduction alternatives for 2020 propose to provide a greater level of control to inlet flow rates.

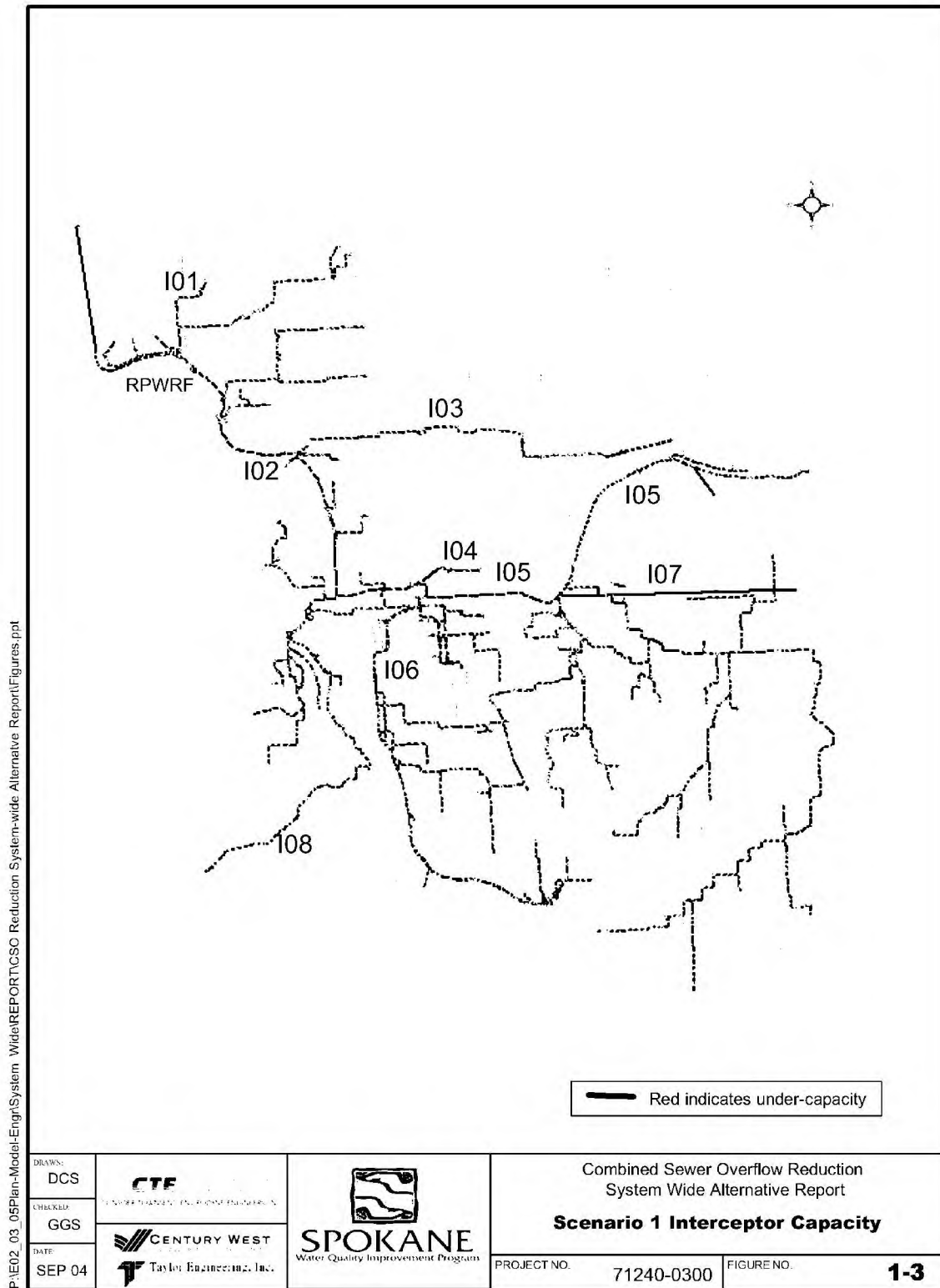
Because of these simulation conditions, the results shown on the following tables and figures indicate a conservative potential for existing and future capacity conditions.

1.5.1 Interceptor System Dry Weather Capacity Summary Existing Conditions

Table 1-5 summarizes the results of the interceptor capacity analysis simulation for the existing dry weather condition (Scenario 1). Existing pipe segments were considered to have their capacity exceeded when full pipe capacity was exceeded.

Under dry weather conditions, the full pipe capacity in Interceptor segment I01 was exceeded.

Figure 1-3 illustrates where interceptor full pipe capacity was exceeded for the existing conditions Dry Weather flow scenario. System pipes whose full pipe capacities are exceeded are denoted in red.



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Table 1-5 Summary of Interceptor Dry Weather Capacity Analyses (2001)

Flow Scenario	Capacity Criteria	Interceptor Segment						
		I01	I02	I04	I05	I06	I07	I08 ⁽¹⁾
Scenario 1	Exceeds Full Pipe Capacity	✓						
	Number of Pipes Exceeding	2 of 33 (Lower Section)						
	Percent of Full Pipe Capacity	103 to 107%	57%	43%	50%	36%	45%	Peak Flow Rate is 18% of Clarke Pump Station Capacity

⁽¹⁾ Clark Avenue pump station capacity was upgraded to 17.3 mgd, per City staff, July 2004

1.5.2 Interceptor System Wet Weather Capacity Existing Conditions

Table 1-6 summarizes the results of the interceptor capacity analysis simulations for existing wet weather conditions (Scenario 2). The CSO Design Event is applied to the collection system as defined in Scenario 2 and assumes no CSO reduction facilities are implemented. Similar to the dry weather scenario, existing pipes were considered to have their capacity exceeded when full pipe capacity was exceeded.

Table 1-6 Summary of Interceptor Wet Weather Capacity Analyses (2001)

Flow Scenario	Capacity Criteria	Interceptor Segment						
		I01	I02	I04	I05	I06	I07	I08 ⁽¹⁾
Scenario 2	Exceeds Full Pipe Capacity	✓	✓	✓	✓	✓		
	Number of Pipes Exceeding	2 of 33 (Lower Section)	10 of 31 (Lower Section)	13 of 24 (Lower Section)	3 of 81 (Upper Section)	20 of 68 (Mid & Lower Sections)		
	Percent of Full Pipe Capacity	110 to 112%	102 to 106%	115 to 229%	101 to 105%	101 to 151%	60%	Peak Flow Rate is 78% of Clarke Pump Station Capacity
	Surface Flooding Occurs			✓ (Upper Section)				

⁽¹⁾ Clark Avenue pump station capacity was upgraded to 17.3 mgd, per City staff, July 2004

Except for Interceptor Segment I07, whose capacity was not exceeded under this scenario, these results show that the existing full pipe capacity is exceeded within all other interceptor segments. The extent to which simulated full pipe capacity was exceeded within each interceptor segment is dependent on specific pipe hydraulic conditions and flow loads to each interceptor segment including the unregulated Rainfall Dependent Flow entering the sewer system from previously separated areas. The simulated duration of this capacity condition is relatively short, on the order of one to two hours, except for areas that showed capacity deficiencies under the Dry Weather Scenario. This shortness is due in part to the use of an SCS Type II storm distribution and incremental Snow Melt for CSS areas; the tributary areas to Interceptor Segments I03 and I04; and the Post Street Bypass.

Although the CSO Design Event generates flows in excess of interceptor full pipe capacity, lesser rainfall events may also cause interceptor full pipe capacity to be exceeded due to the existing CSO regulators and their configurations.

Figures 1-4 illustrates the extent of interceptor full pipe capacity which was exceeded for the Wet Weather flow scenario. System pipes whose full pipe capacities are exceeded are denoted in red.

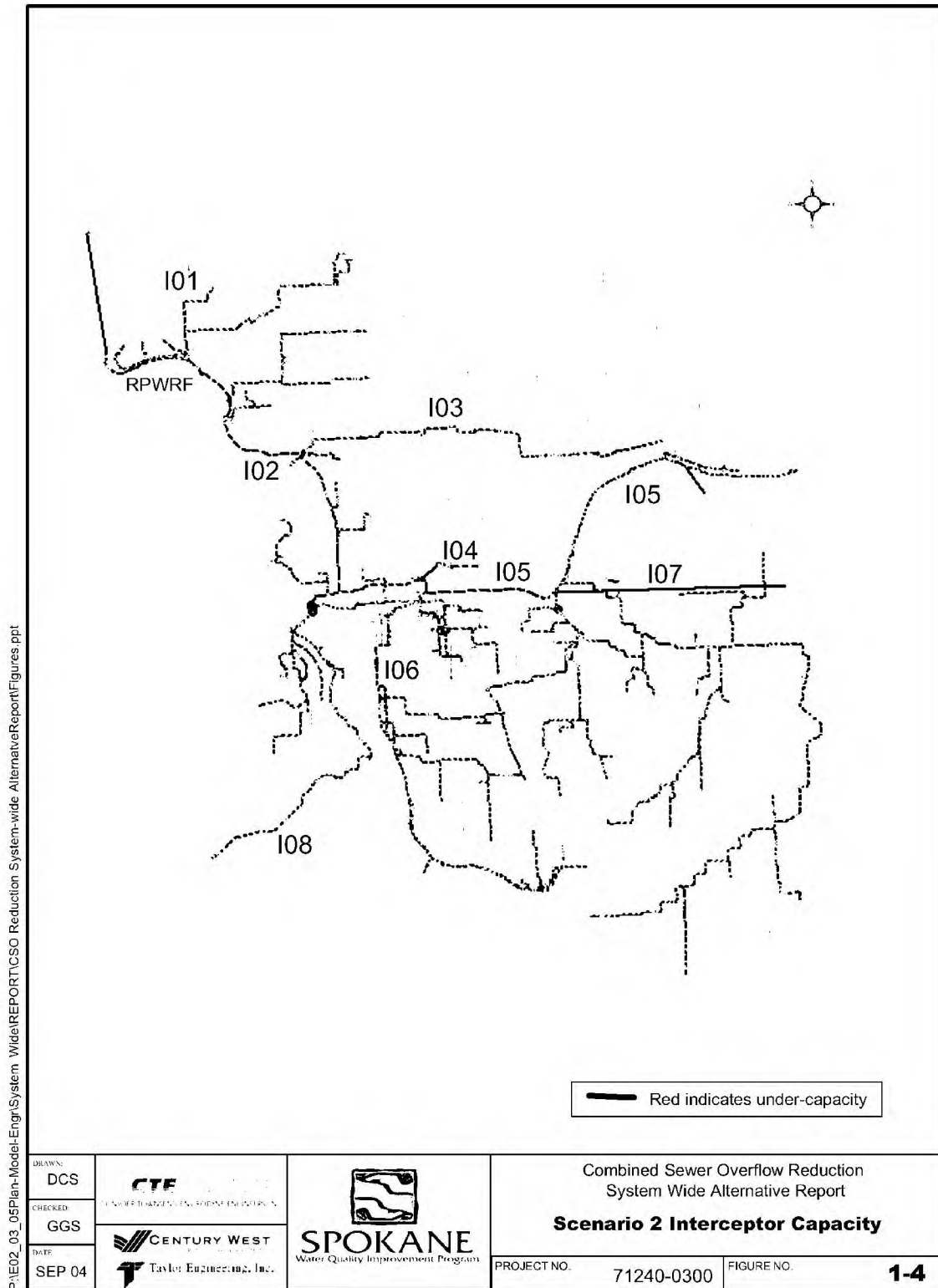
1.6 Baseline CSO Frequency and Volume

The 1994 Plan baseline CSO volumes and frequencies are shown in **Table 1-7**.

Table 1-7 Summary of Baseline CSO Volume and Frequency, (1994 Plan)

CSO Basin	Baseline Annual CSO Quantities	
	CSO Volume (million gallons)	CSO Frequency (events)
CSO Basin 02 ¹	0.03	1
CSO Basin 03 eliminated	-----	-----
CSO Basin 06	14.12	34
CSO Basin 07	0.81	13
CSO Basin 10	0.27	7
CSO Basin 12	9.65	35
CSO Basin 14	0.86	17
CSO Basin 15	4.47	34
CSO Basins 16 & 18	0.50	12
CSO Basins 19 ²	0.00	0
CSO Basin 20	0.55	3
CSO Basin 22b	0.00	0
CSO Basin 23	1.69	18
CSO Basin 24	2.12	3
CSO Basin 25	0.35	19
CSO Basin 26 ³	35.27	42
CSO Basin 33a	0.00	0
CSO Basin 33b	2.30	5
CSO Basin 33c	0.12	11
CSO Basin 33d	2.03	42
CSO Basin 34	11.78	13
CSO Basins 38	0.28	10
CSO Basins 39	1.06	34
CSO Basins 40	1.45	32
CSO Basin 41	0.52	11
CSO Basin 42 ⁴	0.01	2
City Total	90.51	398

- 1) The Volume & Frequency for CSO Basin 2 has been adjusted to reflect the implementation of the CSO control facility for CSO Basins 2 & 3.
- 2) CSO 19 Regulator has been reassessed to ascertain compliance status. The regulator requires modification to assure compliance.
- 3) The Volume & Frequency for CSO Basin 26 has been adjusted to reflect the actual regulator threshold in 1994.
- 4) The volume and frequency for CSO Basin 42 has been modified to reflect modification of the regulator.



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Chapter 2: Initial System-Wide Alternative Development

This chapter provides descriptions of the following:

- The basis for identifying CSO reduction technologies and initial application of such technologies to individual basins
- Identification of general system-wide concepts
- Identification of initial system-wide alternatives
- Assumptions for developing initial system-wide alternatives, including modeling assumptions and cost estimate assumptions
- Development of initial system-wide alternatives

2.1 CSO Reduction Technologies and Basin-specific and System-wide Application

The CSO reduction technologies that were considered for the City's CSO reduction program are listed in the following, as summarized from the draft Memorandum *Combined Sewer Overflow Reduction Alternative Technologies Report* (CTE Engineers, February 2000):

- **Source Controls** - Street Sweeping, Combined Sewer Flushing, Catch Basin Cleaning, Industrial Pretreatment, Construction Site Erosion Control, Enhanced BMPs, Onsite Domestic Wastewater Storage, Garbage Disposal Ban
- **Inflow Reduction Techniques** - Upland Stormwater Storage in Swales, Stormwater Drywells, Separation of Sanitary / Storm Sewer, Stream Diversion, Roof Leader Disconnects/Roof Storage, Reduction of I/I
- **Sewer System Upgrade Or Optimization** - Static Flow Control/Regulator Consolidation, In-line Storage in Existing System, Variable Flow Control, Instrumentation and Controls/Real-time Control
- **Storage** - Open Concrete Tanks, Closed Concrete Tanks (off line), Oversized Conduits (in line), Tunnels
- **Treatment** □Physical (Vortex separator, Screening, Ballasted Sedimentation, Flocculation/High-rate Filtration, Chlorination/Dechlorination, Ultraviolet Disinfection, Netting Trash Trap), and Biological (Secondary Wastewater Treatment Plant, Wetlands Treatment)

From this wide range of basic CSO reduction technologies, a set of applicable technologies was selected, as follows:

- **Separation:** Basin sanitary / storm sewer separation, discharge to surface water with stormwater treatment
- **Treatment:** Remote CSO treatment
- **Partial Separation:** Partial sanitary/ storm separation discharges to treatment bio-swales which eventually is discharged to the ground
- **Storage:** In-line or off-line storage

This list represents technologies that historically have been the most successful in achieving cost-effective CSO reduction.

2.1.1 Basin-specific CSO Reduction

Basic CSO reduction technologies were applied to each CSO basin, independent of any other basin or position within the City's collection or interceptor systems, to determine sizes and then costs for basin-specific CSO reduction. This allowed for determination of the most cost-effective CSO reduction measure for each unique basin.

2.1.2 System-wide CSO Reduction

The basic technologies were then applied on a system-wide basis to determine the most cost-effective configurations for CSO reduction across the City. In such an approach, CSO reduction is optimized through the use of the interceptor to alleviate peak flow rate impacts to downstream treatment facilities and the grouping of adjacent basins into a collective CSO reduction facility.

2.1.3 Remote Treatment

The CSO reduction program, basin-specific alternatives considered the use of remote treatment for wet weather discharges, where remote treatment would only provide primary-level treatment plus disinfection. Preliminary cost estimates suggested that the use of remote treatment was the most cost effective CSO reduction technology for several CSO basins.

Following review with City staff and the Department of Ecology (Ecology) staff, it was determined that the use of remote treatment should be considered only as the last viable option for CSO control because of the following:

- The potential of continued CSO discharges with only primary treatment during low river flow conditions.
- The treatment technology's potential inability to react to large fluctuations in flow.
- The treatment technology's lack of reliability in satisfying water quality.
- The treatment technology's uncertain operation and maintenance needs.
- The potential that future regulations would result in more stringent requirements.

Through further discussions with the City, it was determined that if remote treatment were considered, it must satisfy secondary treatment discharge standards. Therefore, for all subsequent evaluations, remote treatment would be selected only if it was overwhelmingly less costly or was justified by other clear and compelling, site-specific reasons.

2.2 Identification of General System-wide Concepts

Twenty-seven (27) general system-wide concepts were developed through a collaborative workshop facilitated by the CSO PMO, where participants consisted of City Engineering staff; Wastewater Management Operation and Maintenance staff; and CSO PMO staff. The underlying concept was to optimize conveyance while maintaining high levels of treatment. The concepts were developed through a brief review and evaluation of each of the 23 CSO Basins to determine a preferred solution for each basin, independent of the interceptor system and other basins. This provided insight into the composition of other alternative concepts. A compilation of these preferred solutions is also advanced as the Basin-preferred concept. These 27 general system-wide concepts are listed in **Table 2-1** and are illustrated in **Figures 2-1 through 2-19**.

2.3 Identification of System-wide Alternatives

These 27 system-wide concepts were expanded into sixty six (66) system-wide alternatives through a subsequent alternative workshop. This step identified facility variations based on the basic concepts. In addition to these 66 initial system-wide alternatives, the preferred CSO reduction alternative recommended in the 1994 Plan was added. The 1994 Plan concept provided limited storage and added conveyance to the RPWRF for wet weather treatment. A complete list of these 67 alternatives and their descriptions is presented in **Table 2-2**.

Table 2-1 System-wide Concepts

Concept	Sub-concept	Sub concept Number	Description/Detail
1. Convey and Treat at RPWRF	a.		Convey Parallel to Existing CSS and Treat at RPWRF
		1.a.i.	Add Interceptor capacity to convey CSO Design Event all the way to RPWRF
		1.a.ii.	Convey CSO Design Event from I02, I04, and I06 (control remaining basins)
		1.a.iii.	Convey CSO Design Event from I02, I04, I06, I05lower, & I07 (store remaining basins)
	b.		Convey or Control Through Diversions Via New Route to RPWRF
		1.b.i.	New Pipe Convey CSO Design Event from interceptors on South Hill (I06, I07, and I08) to RPWRF (e.g. along 3 rd Ave.) by new Clarke force main.
		1.b.ii.	Convey CSO Design Event from I08 by new Clarke force main to RPWRF, store remaining basins
		1.b.iii.	Convey CSO Design Event from I06 and I08 by new Clarke force main to RPWRF, store remaining basins
		1.b.iv.	Convey CSO Design Event from I06, I07, and I08 by new Clarke force main to RPWRF, store remaining basins
		1.b.v.	Convey CSO Design Event from I05, I06, I07, and I08 by new Clarke force main to RPWRF
		1.b.vi.	Divert I03, CSO 6, 7, and 10 with new interceptor to RPWRF therefore increasing interceptor capacity for remaining wastewater loads; store remaining basins
		1.b.vii.	Divert and convey I05 and I07 via a route along I03 directly to RPWRF; store remaining basins
	c.		Convey or Control Through Diversions to Future Spokane County Treatment Plant
		1.c.i.	Increase Interceptor capacity to convey CSO Design Event from I05 and I07, except divert dry weather flow from I07 to new County Plant
		1.c.ii.	Increase Interceptor capacity to convey CSO Design Event from I07, except divert dry weather flow from I05 and I07 to new County Plant
	d.		Convey or Control Through Diversions to Other Interceptors Conveying to RPWRF
		1.d.i.	Store I05 upper wet weather flows and pump to I03
		1.d.ii.	Divert I06 wet flows (mostly CSO 24a) to I08
	e.		Convey or Control Through Diversions to a Regional WWTP
		1.e.i.	West Side Secondary Treatment Plant (near Clarke Avenue pump station)
		1.e.ii.	Regional CSO Treatment Plant (near Clarke Ave. Pump Station)
		1.e.iii.	Eastside City Secondary Treatment Plant
2. Basin Groups	a.	2a	Basin <input type="checkbox"/> preferred: CSO 42-Storage or Treat; CSO 41-Separation or Treat; CSO 38, 39, and 40-Storage; CSO 34 Storage or Treat; CSO 33 a,b,c, and d-Storage or Treat; CSO 20- Storage downstream; 24a, 24b, and 25 Storage or Treat; CSO 26-Storage or treat; CSO 23-Treat; 16a, 16b, and 18-Storage or Treat; CSO 14 and 15-Storage or Treat; CSO 10 and 12-Storage or Treat; and CSO 6 and 7-Storage or Treat
		2b	Remote Treatment <input type="checkbox"/> All
		2c	Storage <input type="checkbox"/> All
		2d	Separation <input type="checkbox"/> All
		2e	Separation and Storage of Storm Flows to RPWRF
		2f	Intangible Consideration for Basin-preferred
3. Interceptor Storage	a.	3a	Store I03 and CSOs 6, 7, and 10 with New In-line Pipe Storage to RPWRF
	b.	3b	In-line Interceptor Storage: I05 Lower, I04, I02, I07 (and CSO 34), and I06 (CSO 24a)
	c.	3c	Store Unregulated Wet Weather Flow Areas (Interceptor I03 and I04 and Post Street)
	d.	3d	Tunnel Storage from I06 to RPWRF

Table 2-2 System-wide Concept Alternatives

System-wide Concept Number	Alternative	Alternative Description
1.a.i.		Convey CSO Design Event to RPWRF (ALL)
1.a.ii.		Convey CSO Design Event I02, I04, and I06 (control remaining basins)
	Option 1	Convey all from 14,15, 20, 24, 26, store remaining except 41
	Option 2	Same as Option 1, except storage for 14 and 20
	Option 3	Same as Option 2, except store I03 & I04 & Post St.
	Option 4	Same as Option 3, except basin preferred on remaining basins
	Option 5 (Threshold at Inflection)	Same as Option 3, except Storage on conveyed regulators
	Option 5 (Threshold at 25% of Peak)	Same as Option 3, except Storage on conveyed regulators
	Option 5 (Threshold at 50% of Peak)	Same as Option 3, except Storage on conveyed regulators
	Option 5 (Threshold at 75% of Peak)	Same as Option 3, except Storage on conveyed regulators
	Option 6	Same as Option 5 with Storage at Inflection, except basin preferred on remaining basins
	Option 7	Same as Option 6 with county flows reduced due to SCWTP
1.a.iii.		Convey CSO Design Event from I02, I04, I06, I05 Lower, & I07 (store remaining basins)
	Option 1	Convey all up to I07
	Option 2	Convey all up to I07, except store I03, I04, Post Street
	Option 3	Convey all up to I07, except store I03, I04, Post Street, and storage on conveyed regulators
1.b.i.		New Pipe Convey CSO Design Event from interceptors on South Hill (I06, I07, and I08) (3rd Ave.)
	Option 1	Convey portions of 34, 33b, 26, 24a and I08. Store remaining CSO Basins.
	Option 2	Same as Option 1 with Basin Preferred instead of Storage
	Option 3	Same as Option 2 with Interceptor Storage @ I03, I04, & Post (optimized)
1.b.ii.		Convey CSO Design Event from I08 by new Clarke force main to RPWRF
	Option 1	Convey CSO Design Event from I08 by new Clarke force main Store others
	Option 2	Same as Option 1 with Basin preferred
	Option 3	Store I03 & I04 Optimize Storage in Others
	Option 4	Same as Option 3 with Basin Preferred
1.b.iii.		Convey CSO Design Event from I06 and I08 by new Clarke force main to RPWRF, store remaining basins
	Option 1	Convey I06 and I08 via new Clark force main, store remaining
	Option 2	Same as Option 1 with Basin Preferred
1.b.iv.		Convey I06, I07, and I08 by new Clarke force main to RPWRF, store remaining basins
	Option 1	Convey 34, 25, 22B, 16A, 16B, 18, 19, Most of 26, 24A, 24B. Store Others.
	Option 2	Same as Option 1 with Basin Preferred
	Option 3	Same as Option 1 with I03, I04, and Post Street Wet Weather Storage
1.b.v.		Convey CSO Design Event from I05, I06, I07, and I08 by new Clarke force main to RPWRF
	Option 1	Convey CSO Design Event from I05, I06, I07, and I08 by new Clarke force main to RPWRF
		Divert I03, CSO 6, 7, and 10 with new interceptor to RPWRF
	Option 1	Divert I03, CSO 6, 7, and 10 with new interceptor, store remaining basins
	Option 2	Same as Option 1, except basin preferred on remaining basins
	Option 3	Same as Option 2, except store I03 & I04 & Post St.
	Option 4	Same as Option 3, except Storage on conveyed regulators

System-wide Concept Number	Alternative	Alternative Description
1 b vii.		Divert & convey I05 & I07 along I03, conveying CSO 6, 7, & 10 directly to RPWRF. Store remaining basins.
	Option 1	Divert & convey I05 & I07 along I03, conveying CSO 6, 7, & 10 directly. Store Remaining
	Option 2	Same as Option 1, except basin preferred or remaining basins
	Option 3	Same as Option 2, except store I03 & I04 & Post St.
	Option 4	Same as Option 3, except Storage on conveyed regulators
1 c.i		Convey CSO Design Event from all except dry or wet flow from I07 and I05 upper, diverted to new SCWTP.
	Option 1	Convey all except dry weather flow from I07, diverted to new SCWTP
	Option 2	Convey all except dry flow from I07 and I05 upper, diverted to new SCWTP
	Option 3	Same as Option 2, but store I04 and I03 at Inflection.
	Option 4	Same as Option 1, except all flow from I07, equalized, then diverted to new SCWTP
1 d .		Store I05 upper wet weather flows and pump to I02
	Option 1	Convey all except store I05 Upper wet weather flows and pump to I02
1 d i		Divert I06 wet flows (mostly CSO 24a) to I08
	Option 1	Divert I06 wet flows to I02
	Option 2	Same as Option 1 with Storage at I02, Post St. and I04
	Option 3	Same as Option 2 with Basin Preferred
1 e .		Peoples Park Secondary Treatment Plant
	Option 1	Peoples Park Secondary Treatment Plant & Optimize
1 e i		Regional CSO Treatment Plant (near Clarke Ave. Pump Station)
	Option 1	Regional CSO Treatment Plant. Store all others
1 e ii.		Eastside Secondary Treatment Plant
	Option 1	Eastside Secondary Treatment Plant @ 31 MGD annual average
	Option 2	Eastside Secondary Treatment Plant @ 21 MGD annual average
2 a		Basin-Preferred
2 b		Remote Treatment (a.i)
2 c.		Storage (a.i)
2 d		Separate (a.i)
2 e		Separate and Store (a.i)
2 f		Intangible Basin Factor Preferred
2 g		Basin-Preferred limited to Large Remote Treatment only
3 a		Store I03, CSO 6, 7, and 10 with new in-line pipe storage to RPWRF
	Option 1	I03, CSO 6, 7, & 10 In-line pipe storage. Outlet to RPWRF at Inflection. Store all others.
	Option 2	Same as Option 1, Basin preferred all others
	Option 3	Same as Option 2 with storage @ I03, I04 & Post
3 b		In-line Interceptor Storage: I05, I04, I02, I07 (and CSO 24), and I06 (24a)
	Option 1	In-line Interceptor Storage: I05 lower, I04, I02, I07, and I06
3 c.		Store Unregulated Wet Weather storage for I03, I04, and Post St. Shortcut
	Option 1	Store I04 & Post St. wet weather. Store all others
	Option 2	Same as Option 1 with Basin Preferred
	Option 3	Same as Option 2 with Optimization
	Option 4	Same as Option 1 with Optimization
	Option 5	Same as Option 3 with no NWI. SW @ 11.45 cfs peak
	Option 6	Same as Option 4 with no NWI. SW @ 11.45 cfs peak
3 d		Tunnel Storage from I06 to RPWRF
	Option 1	Tunnel Storage from I06 to RPWRF
	Option 2	Option 1 with Basin Preferred
1994 Plan Recommendation		1994 Plan Recommendation (Storage, Convey & Wet weather treatment @ RPWRF)

2.4 System-wide Alternative Development Assumptions

In order to provide a foundation for equitable comparison and development of the alternatives, a set of model and cost assumptions were applied. These assumptions are summarized below.

2.4.1 Model Assumptions to Determine CSO Reduction Facility Size and Cost Assumptions

The assumptions used to systematically define CSO reduction facilities for the 67 initial system-wide alternatives are presented in Chapter 1 Section 1.4.

2.4.2 CSO Reduction Facility Cost Assumptions

CSO reduction facility construction costs and Operation and Maintenance (O&M) costs are based upon the *Combined Sewer Overflow Reduction Basis of Cost Report* (CTE Engineers, March 2002) and subsequent updates. Wet weather only O&M costs were estimated as defined in the cited cost report and amended by the following memorandum transmitted by letter to the City on October 16, 2003: *Refined Cost Estimating for CSO Program and Impact of Refined Cost Estimating on Selection of Basin Preferred Alternatives*. A total net present value (NPV) cost was calculated for each alternative, where total NPV costs are the sum of the estimated construction costs and the present value of estimated O&M costs.

The following assumptions applied to all alternatives to provide a common basis for cost estimates:

1. Costs are program level, based on R.S. Means Construction Cost Data, historical CSO projects, and manufacturers' information.
2. Estimate year is 2003.
3. Past inflation is based on Engineering News Record Construction Cost Index.
4. Historical costs are adjusted to Spokane using R.S. Means City Cost Index.
5. Present value calculations are based on a 30 year term and an annual discount rate of 4%.
6. Costs include engineering, construction management, and administration at 25% of construction cost. Contingency is included at 15% of construction cost.
7. Storage costs include odor control, pumps, 200 lineal feet of ancillary pipe, manholes, paving, typical rock excavation, trench dewatering, diversions, and self-flushing systems.
8. Property costs are estimated from 130% (City staff 2003) of assessed property value. Required acquisition areas are calculated from the design storage volume, divided by typical 8 ft depth storage facility, and include a 25% buffer area. It should be noted that initial cost estimating (and initial alternative development and cost estimating documentation) did not include property costs; however, all cost values given in this report have been updated to include property costs as part of the overall cost estimate.

2.5 Development of the System-wide Alternatives

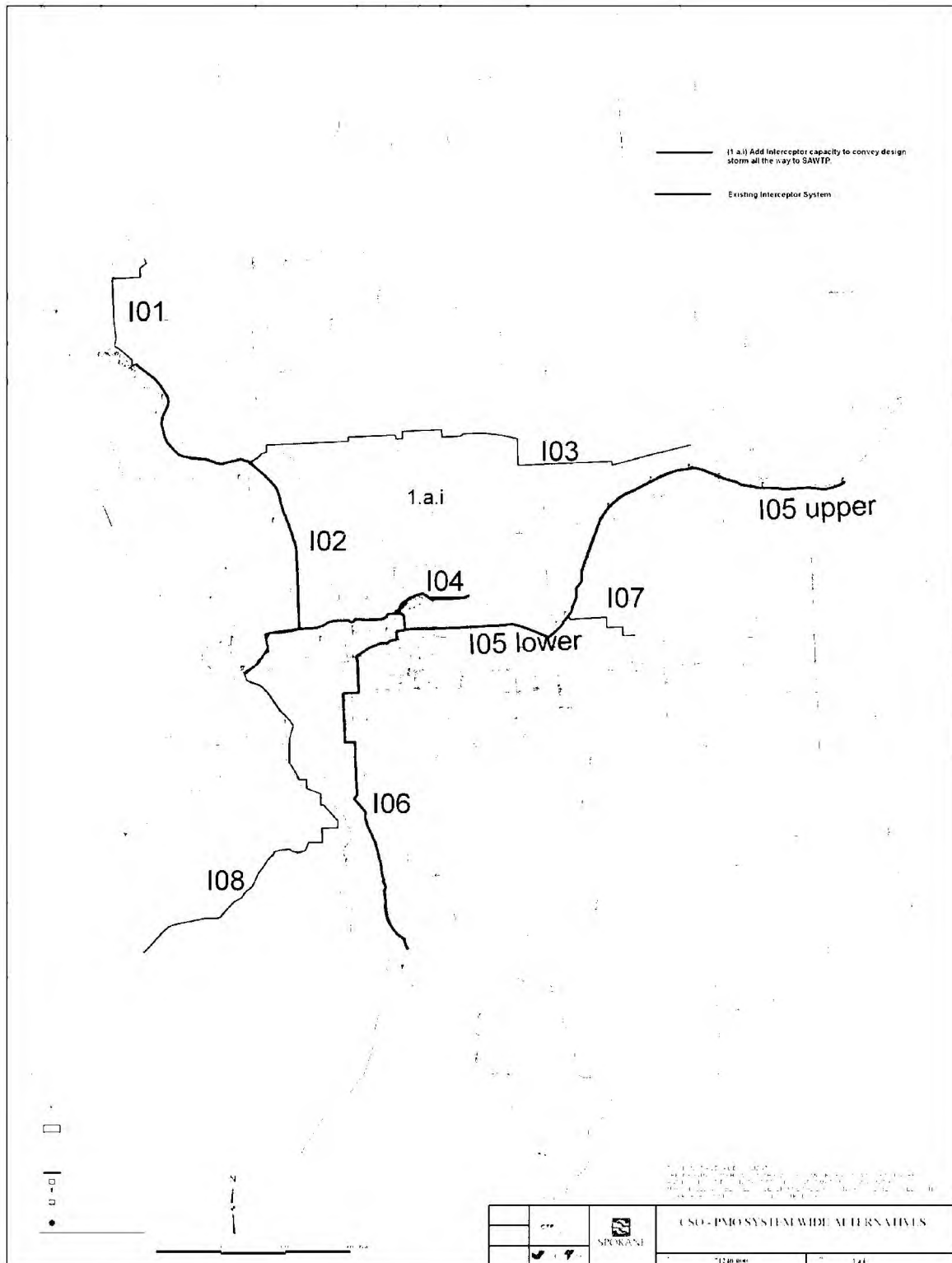
Once the 67 initial system-wide alternatives were identified, simulations were performed applying a single wet weather scenario, Scenario 6 (2020 □ Wet Weather with SCWTP), as described in Chapter 1. This scenario was also applied to the 1994 Plan recommendation to develop updated sizes for the facilities in order to provide compliance based on the current CSO Design Event. This would provide for direct comparison of this alternative to other alternatives identified in this CSO program.

Specific approaches were followed to provide a common basis for developing the models and defining CSO reduction facility sizes or capacities, as follows:

1. The total cost to provide wet weather conveyance is included in the cost estimates for resolving wet weather CSO reduction needs.

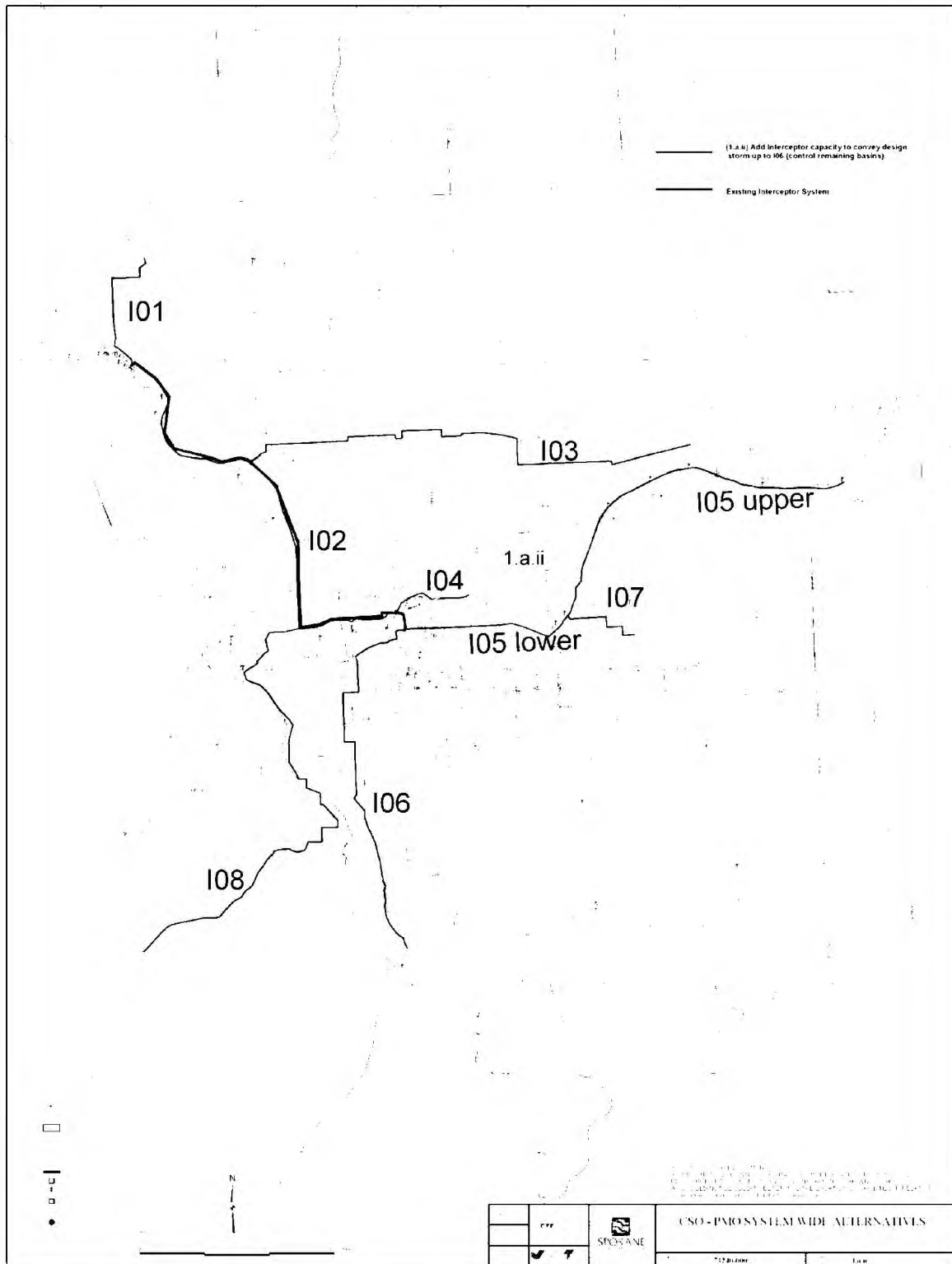
2. Additional conveyance capacity needs are provided for as a relief sewer (new parallel pipe). A depth/diameter ratio of 0.7 is used at design flow rates. This applies to both interceptor and collection system conveyance. Relief sewers are assumed to match existing pipe slopes and depths.
3. Interceptor conveyance capacity needs for alternatives that conveyed collection system peak flow rates were determined by increasing the maximum allowed flow rate to the interceptor. Initial simulations indicated that the cumulative peak flow rate generated from the City's collection system was on the order of 1,200 mgd during the CSO Design Event. To address the high flow rate, the adjusted interceptor inlet flow rates were set at the inflection point of the rising hydrograph curve at the regulator inlet. This therefore, would not allow uncontrolled peak flow rates to enter the interceptor. Excess combined sewer volumes were then diverted to a hypothetical storage facility. This to some degree, controlled peak flow rates to the interceptor.
4. Due to the potential difficulty to site a large storage facility within or near the Central Business District, the first priority for CSO 26 is use of available existing interceptor system capacity. This flow diversion would reduce its storage requirement. Subsequent diversion to available conveyance capacity for storage reduction is prioritized on the next most expensive storage (based on unit cost).
5. The interceptor capacity analyses, as summarized in Chapter 1, indicated that interceptor segment I05 Upper is deficient under Dry Weather flows when County flows are conveyed through I05 Upper. Increased interceptor capacity needs for growth of County flows conveyed to interceptor segment I05 Upper have been identified separately and are not included in this analysis.
6. The baseline for scenarios that include another wastewater treatment plant (SCWTP), flows from the Spokane Valley service area outside of the City of Spokane service area have been set at an annual average flow rate of 10 mgd and a daily peak flow rate of 15 mgd (based upon the contractual flow rate between the City of Spokane and Spokane County).
7. The SCWTP is designed for the treatment of sanitary flows only.

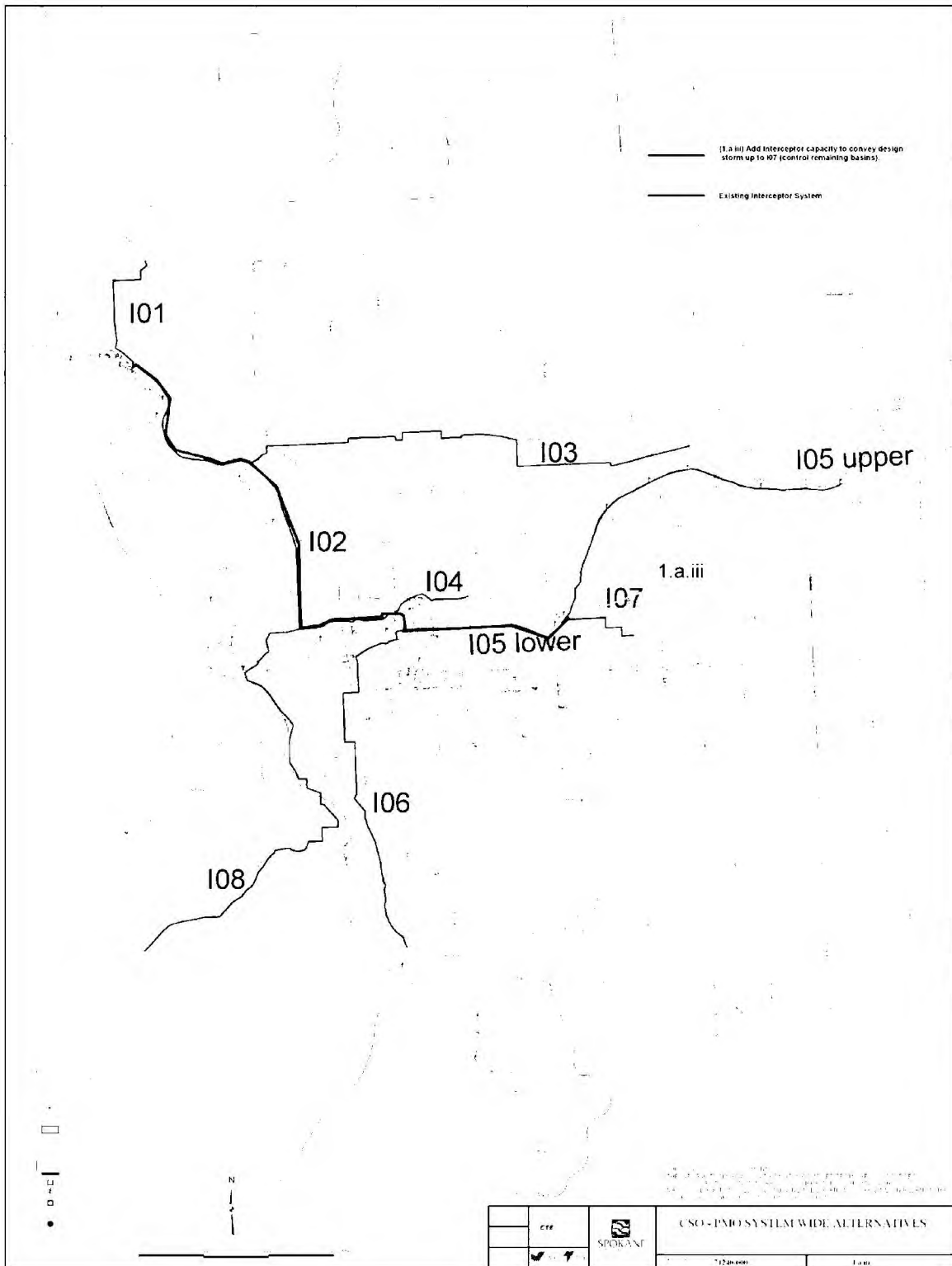
These 67 System-wide CSO reduction alternatives were then evaluated and rated based on screening criteria and a screening process, as defined in the next chapter.



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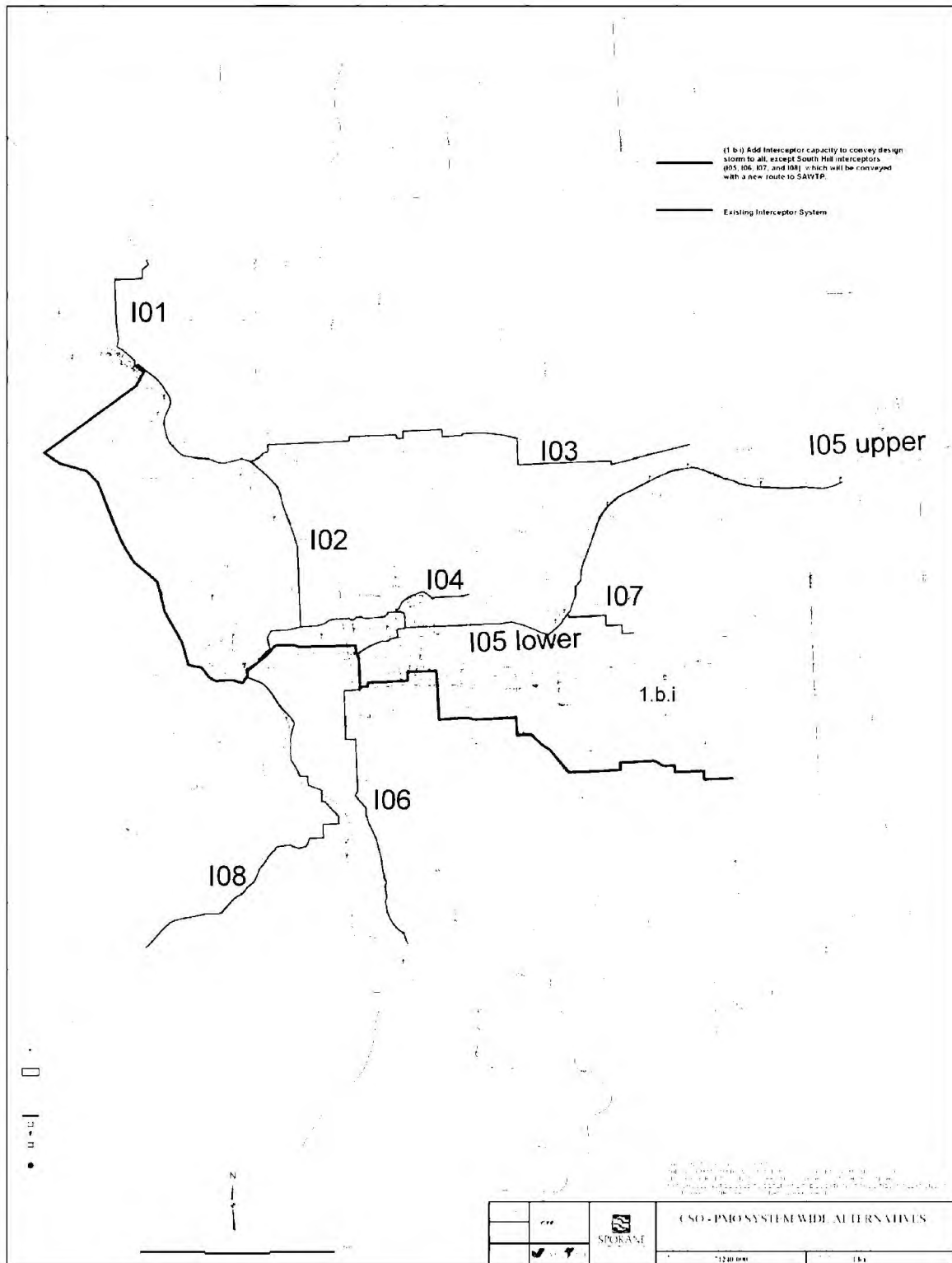
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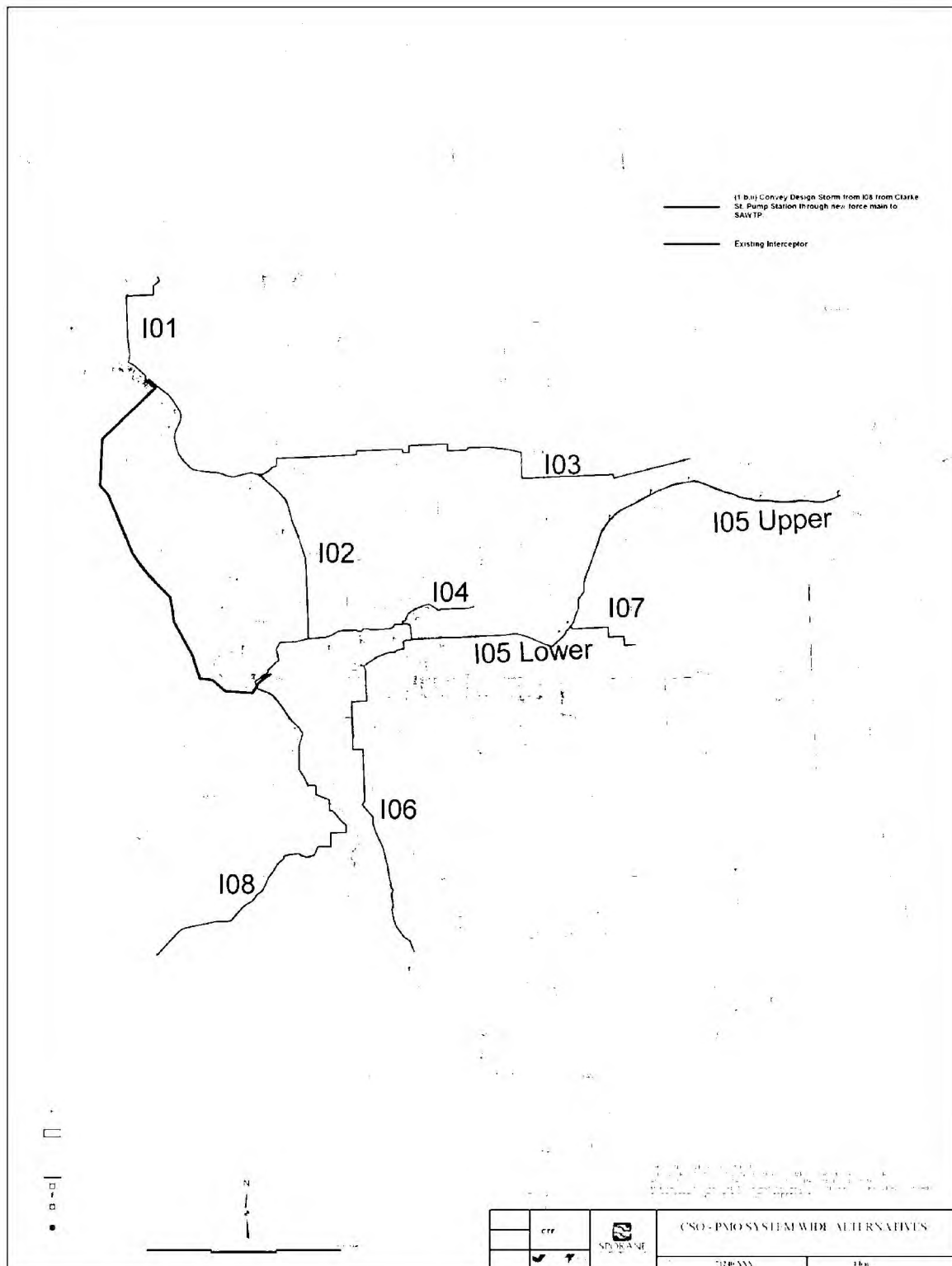
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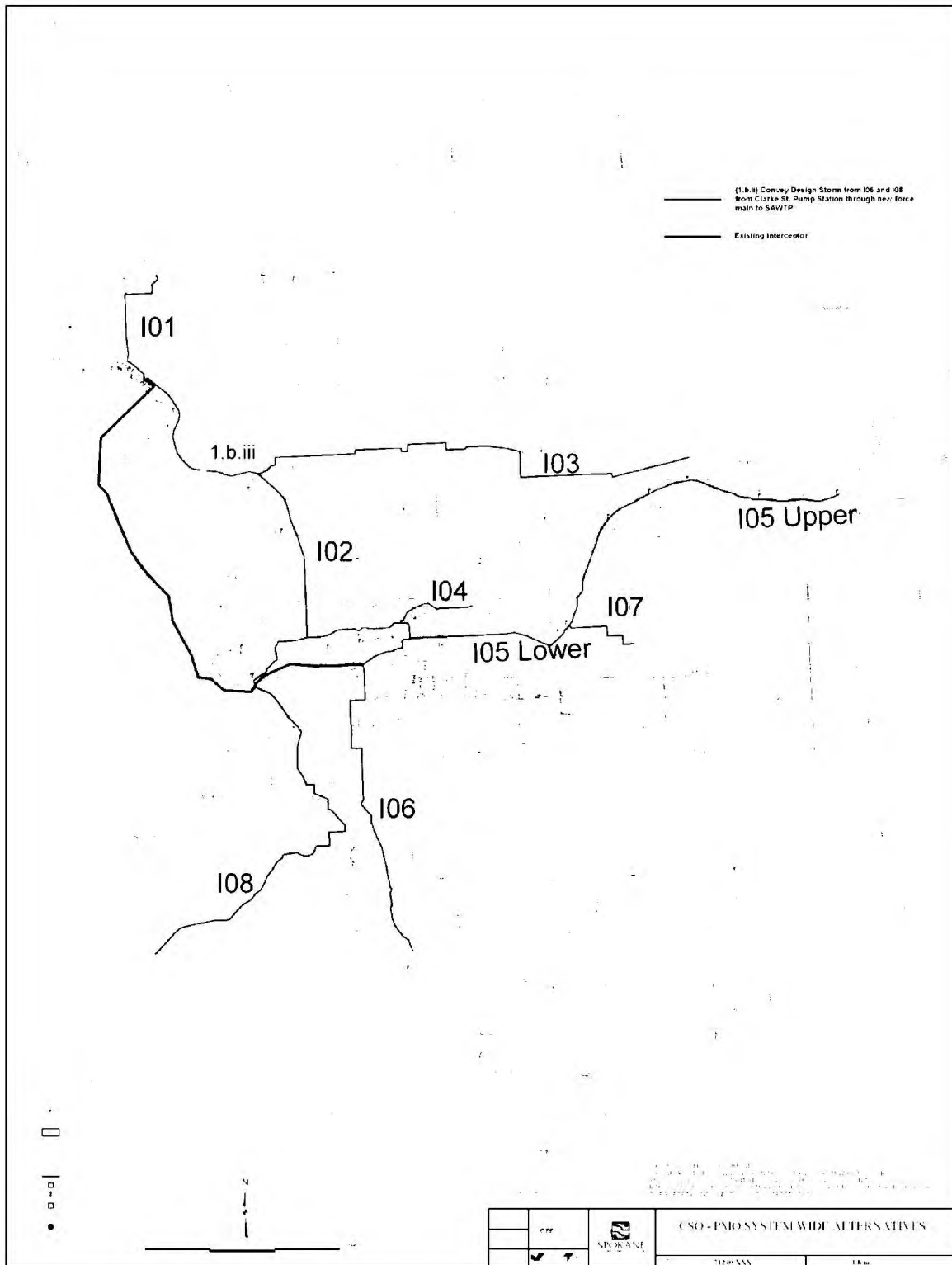
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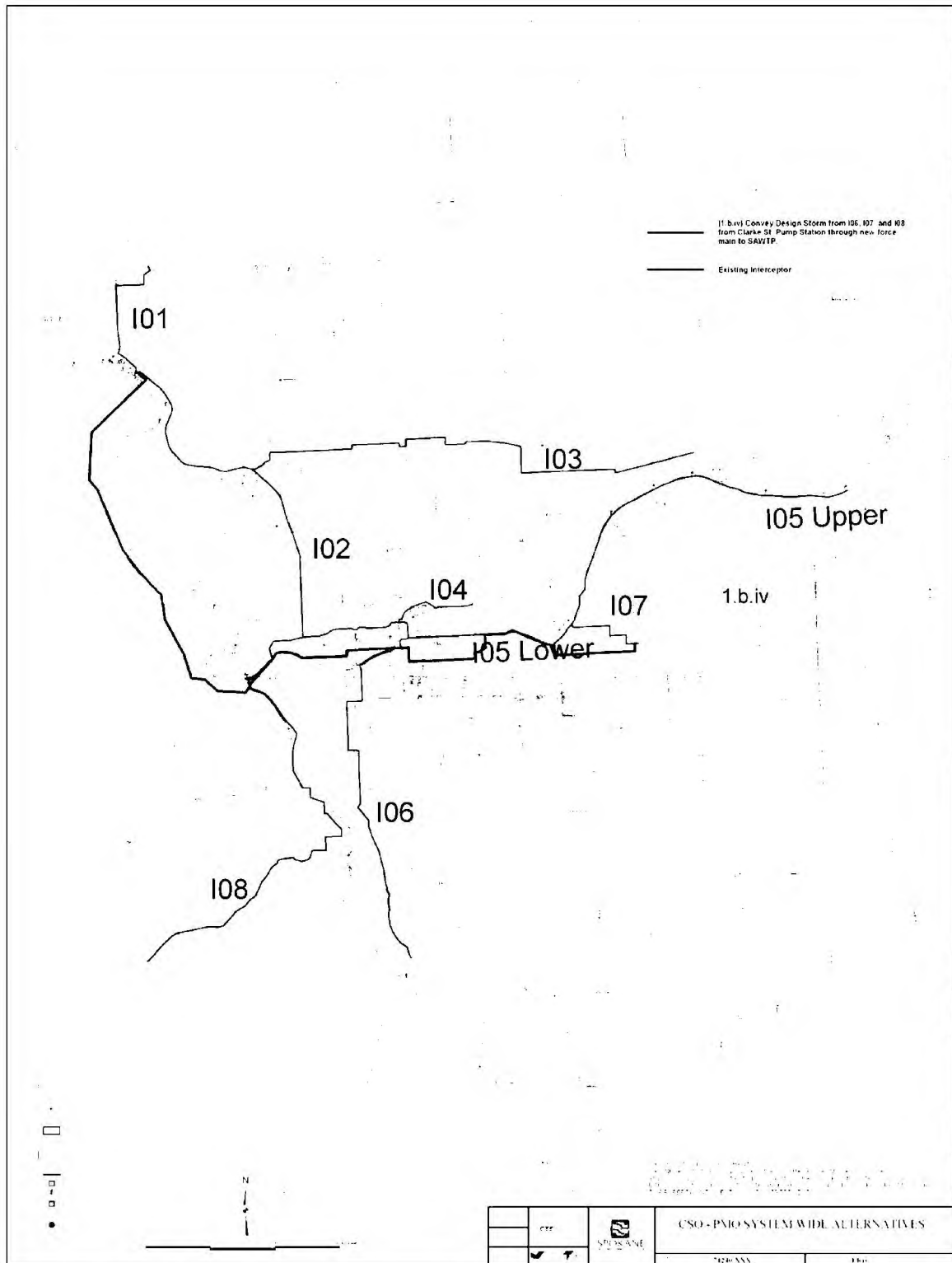
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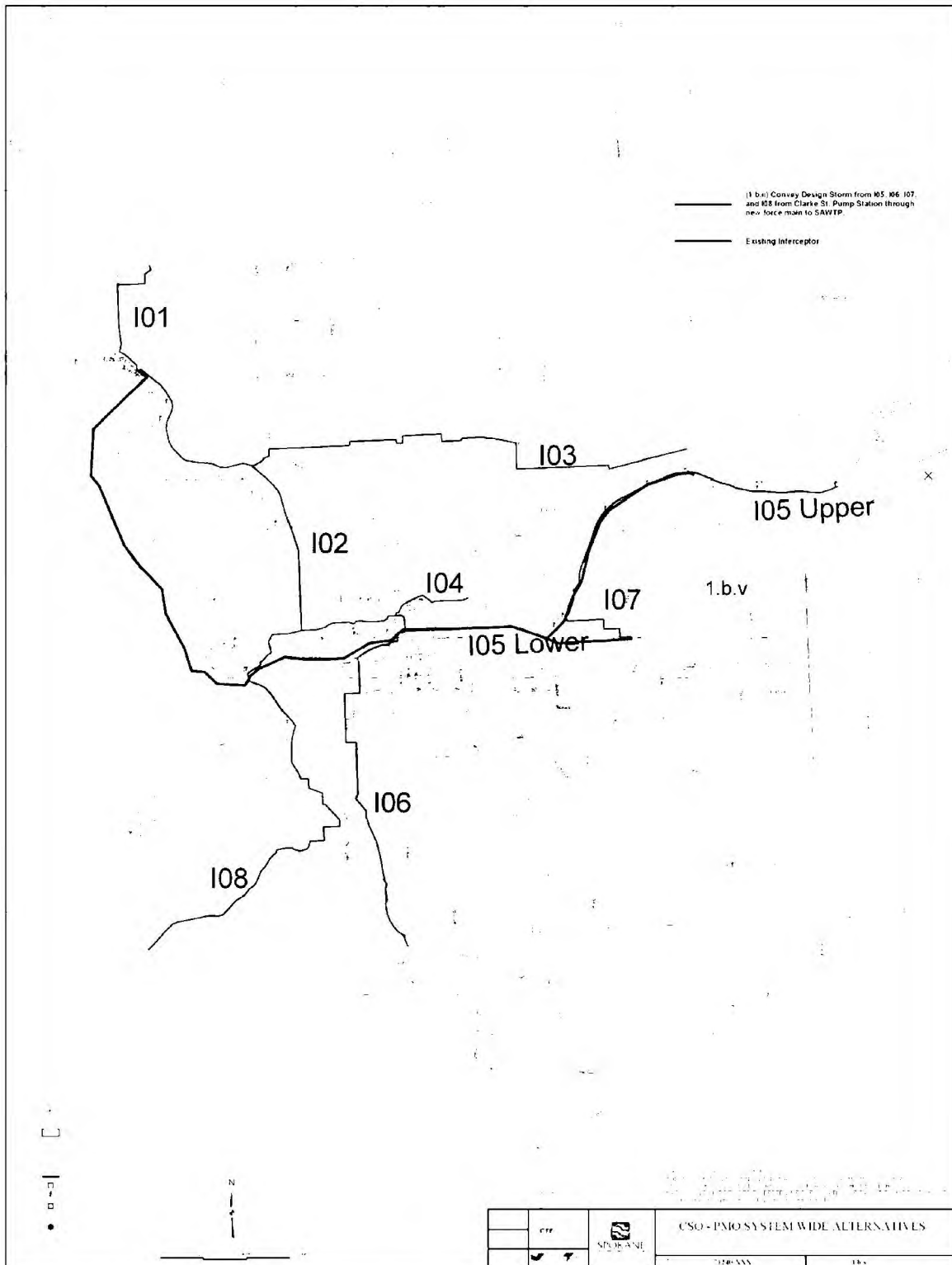
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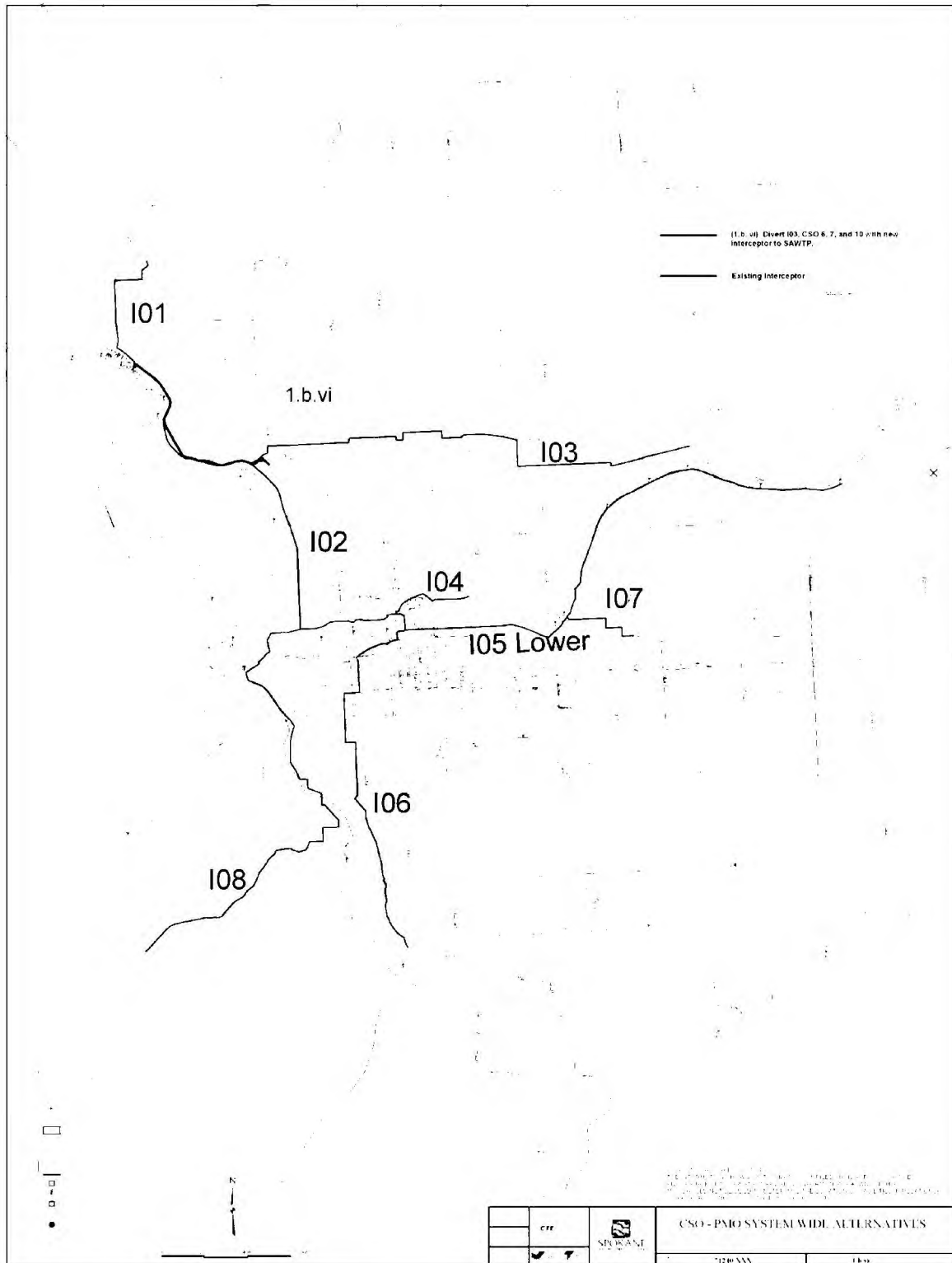
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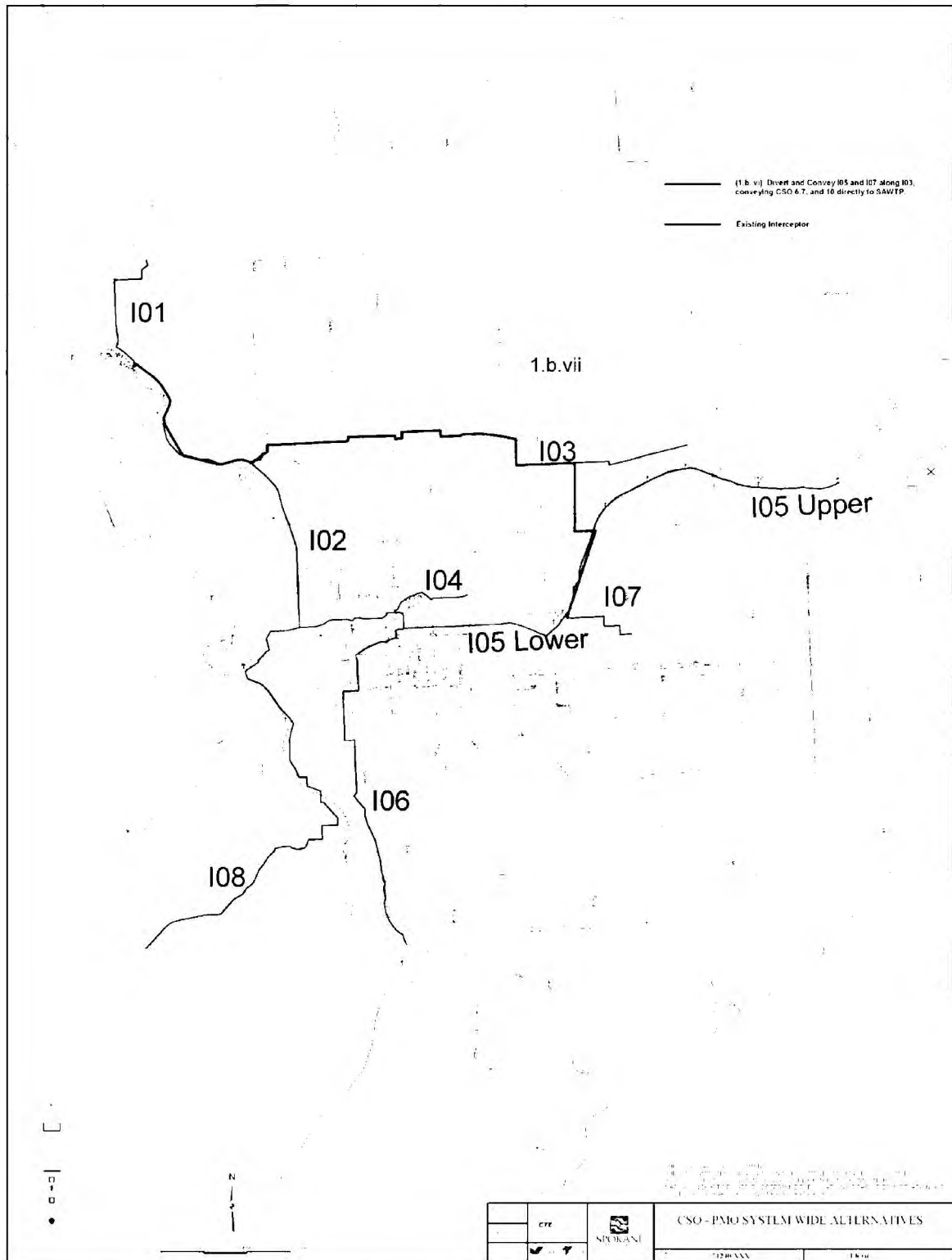
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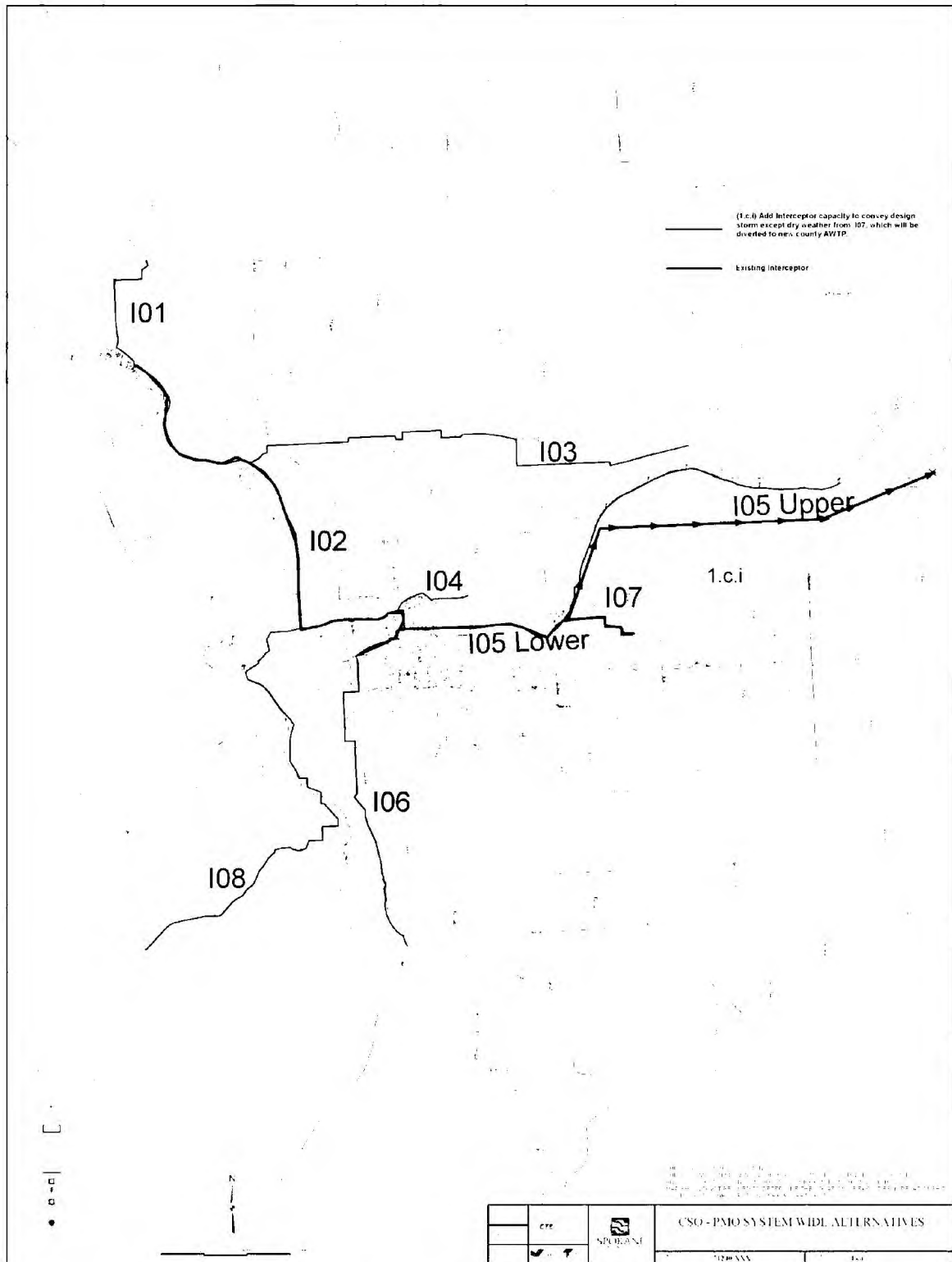
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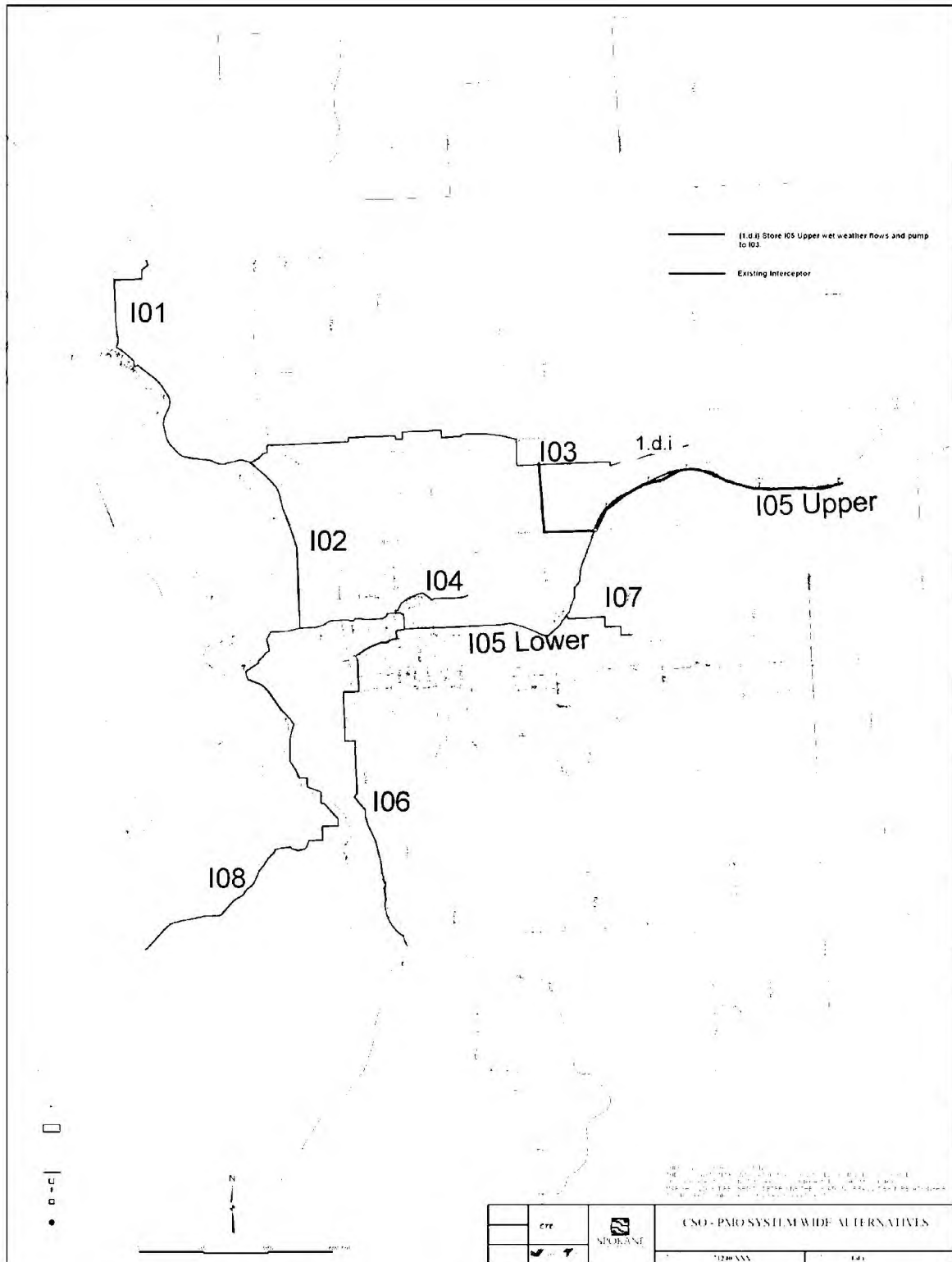
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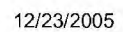
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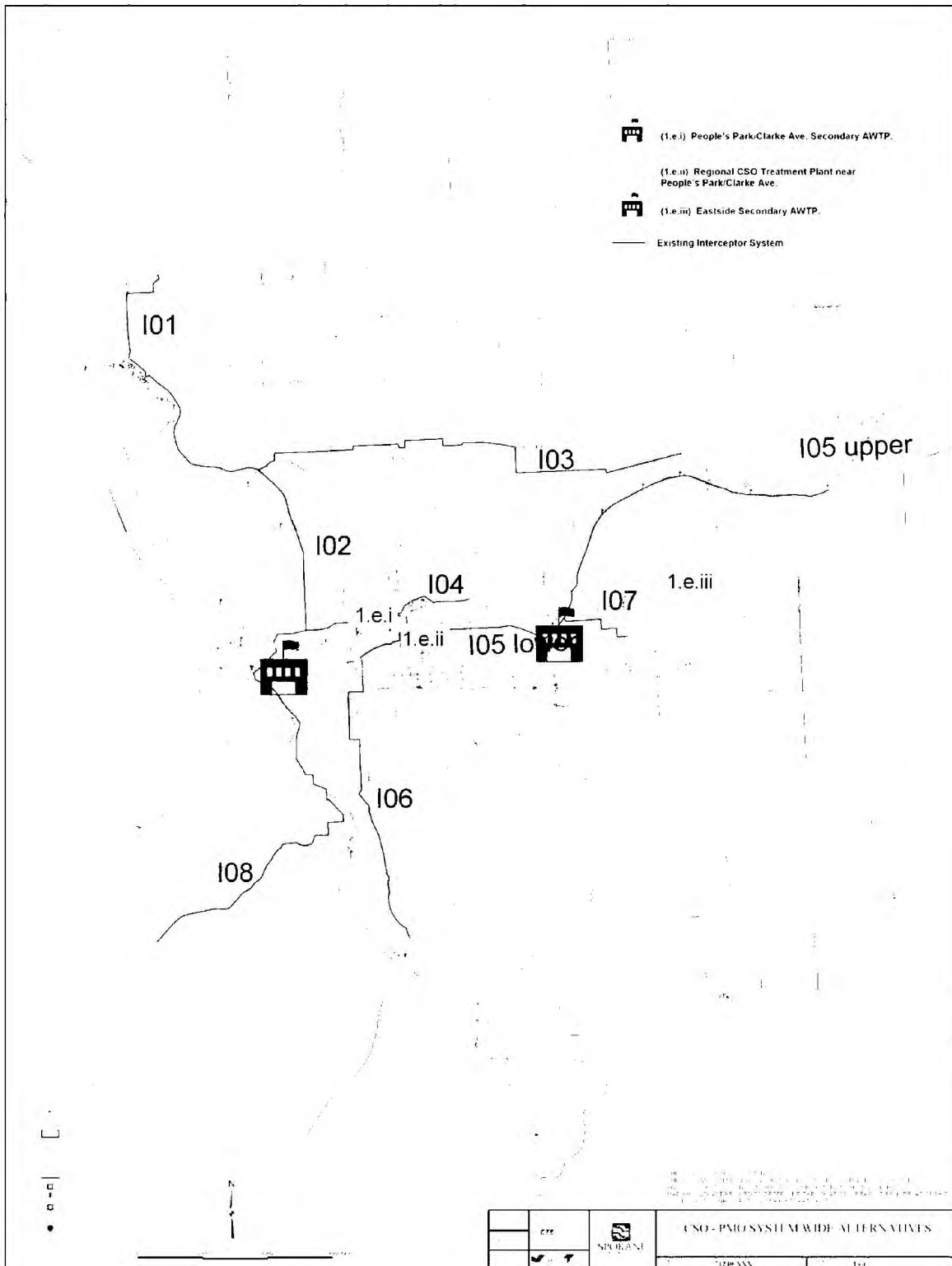
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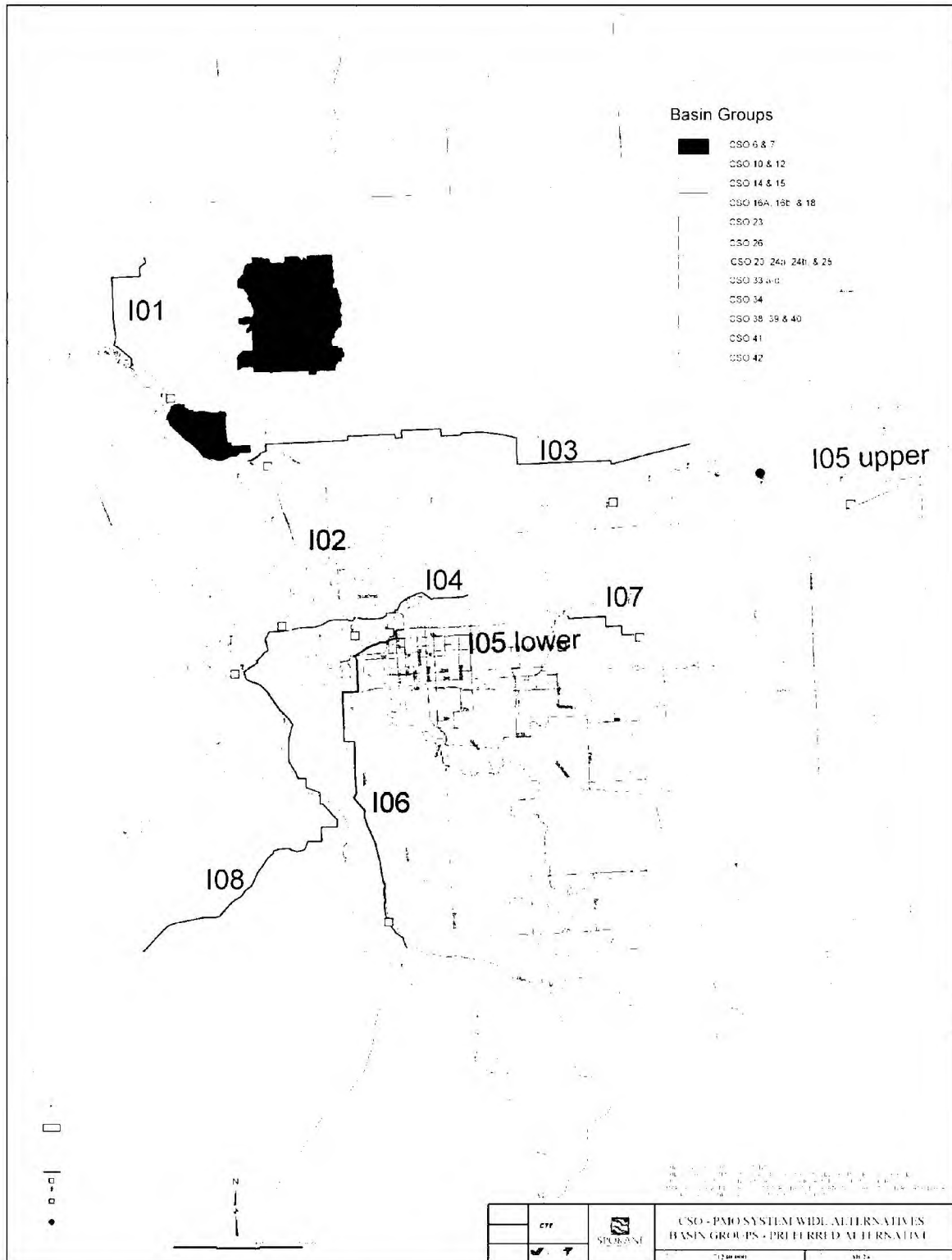
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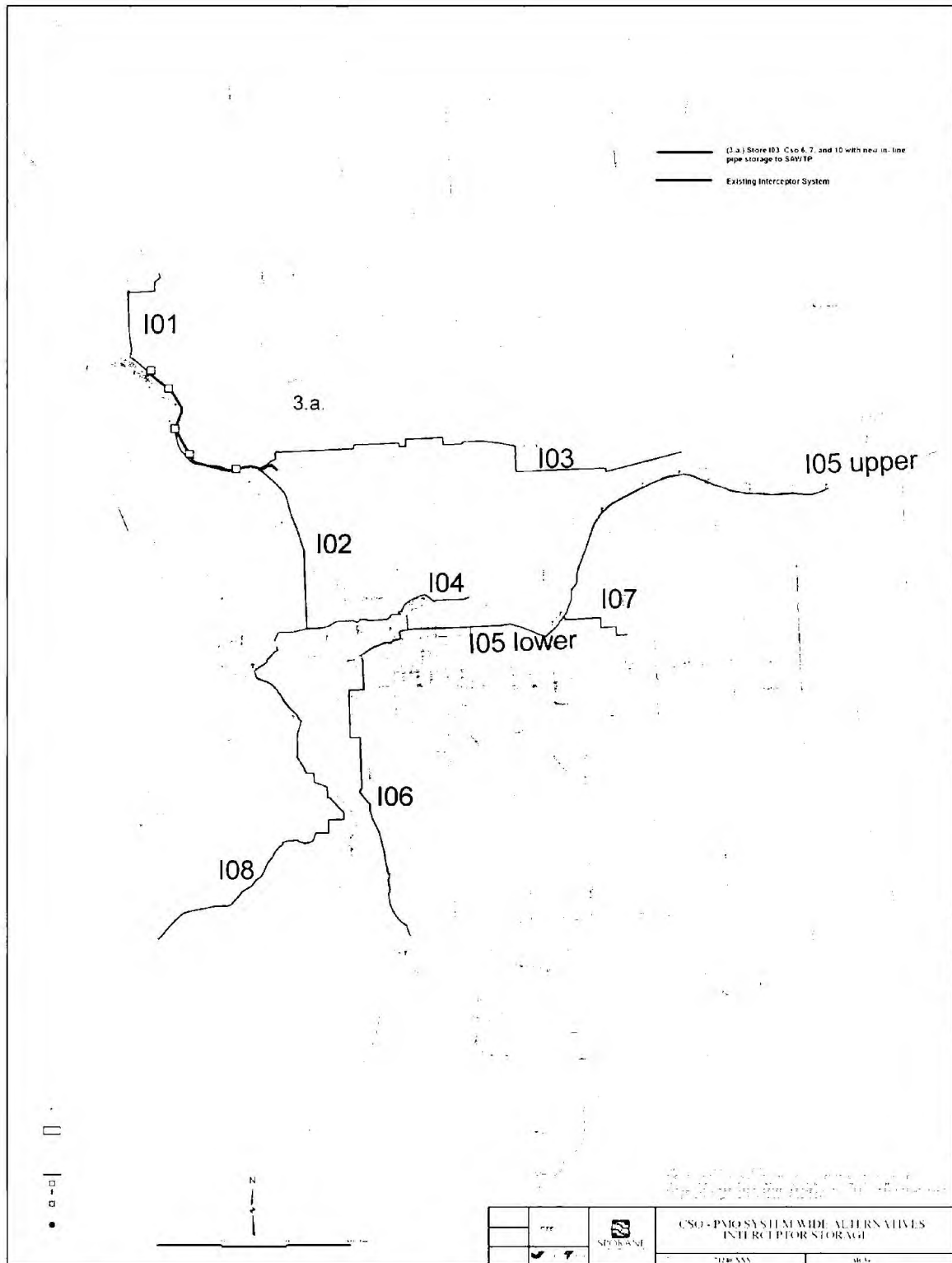
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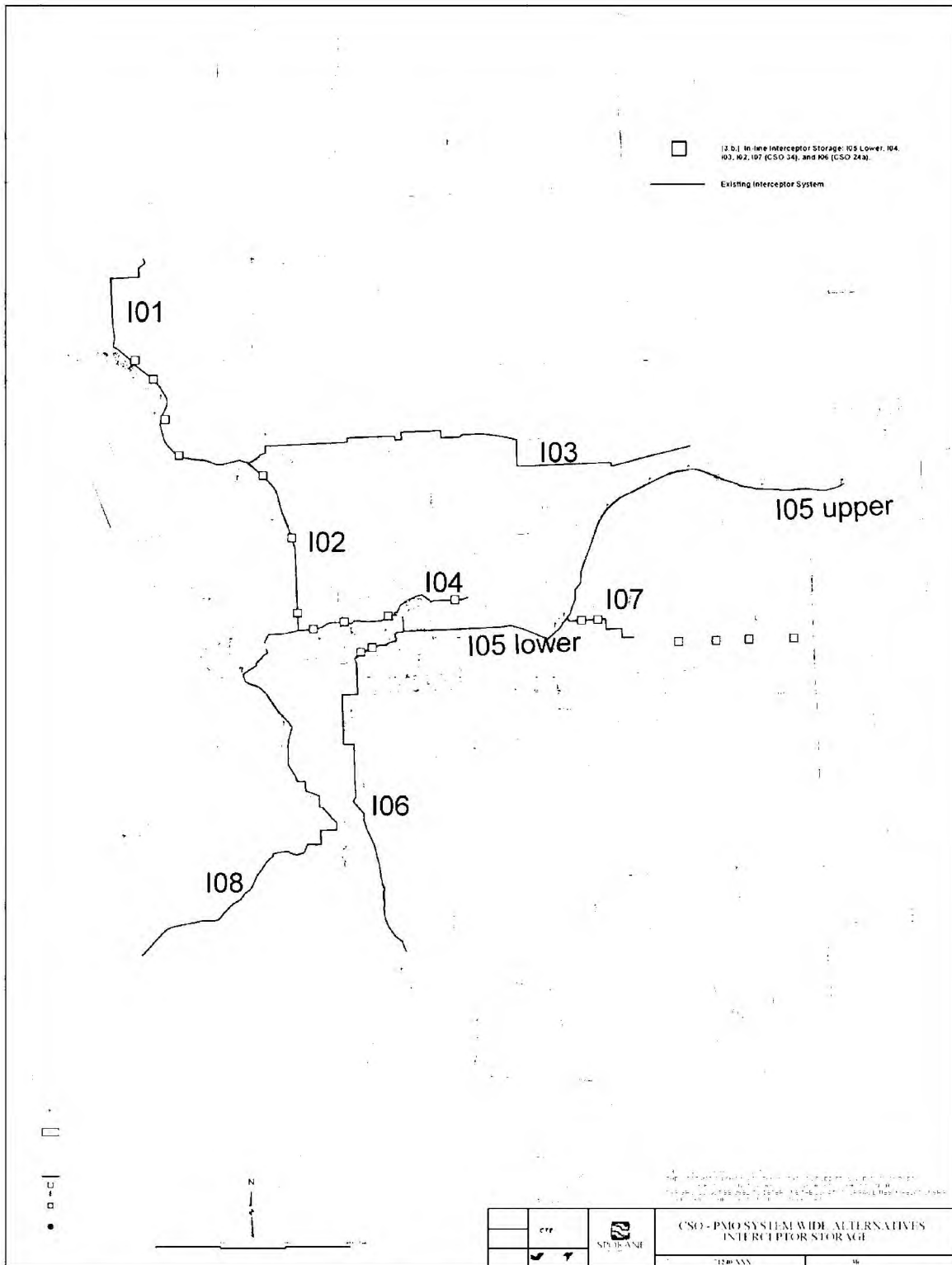
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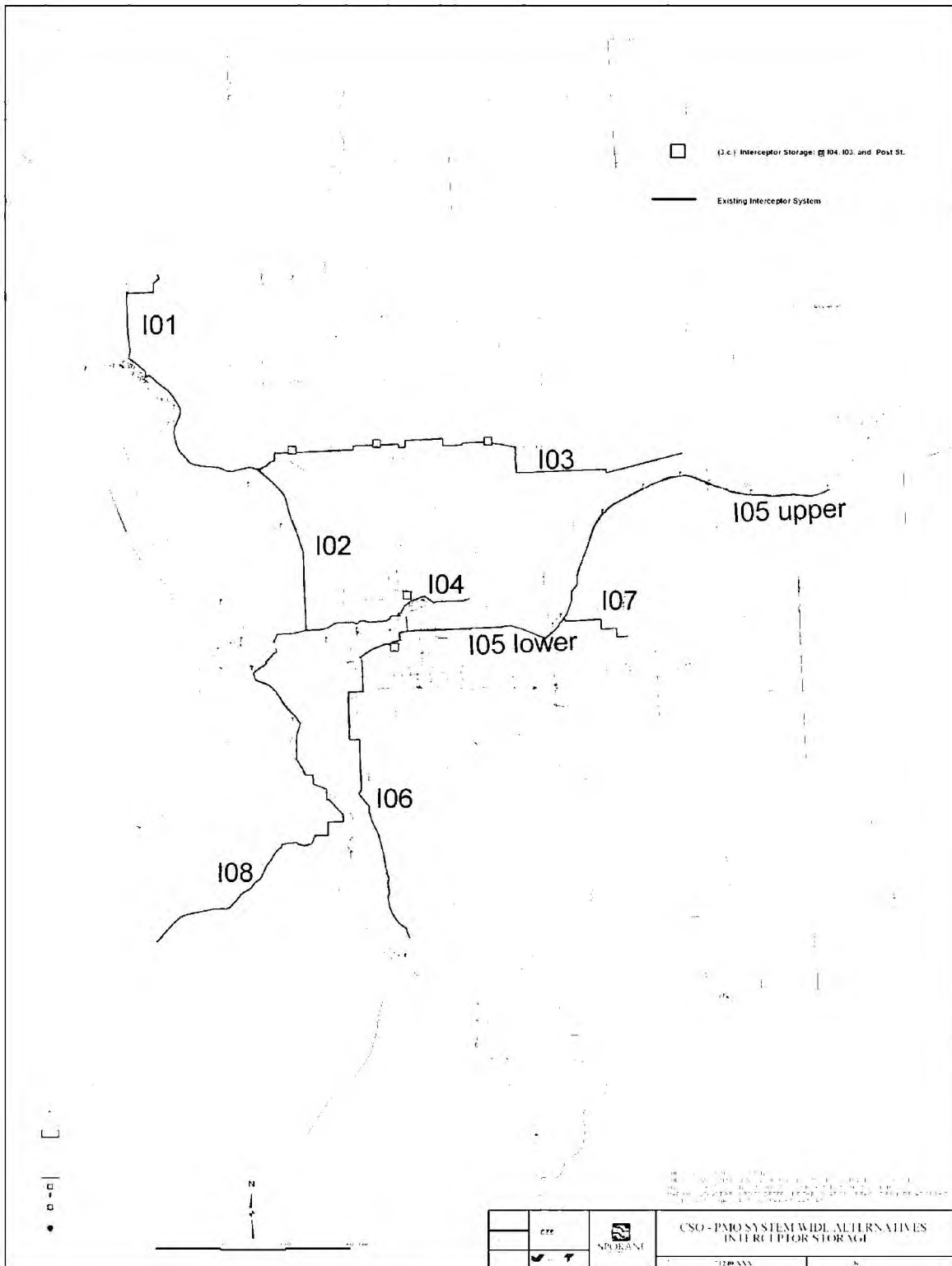
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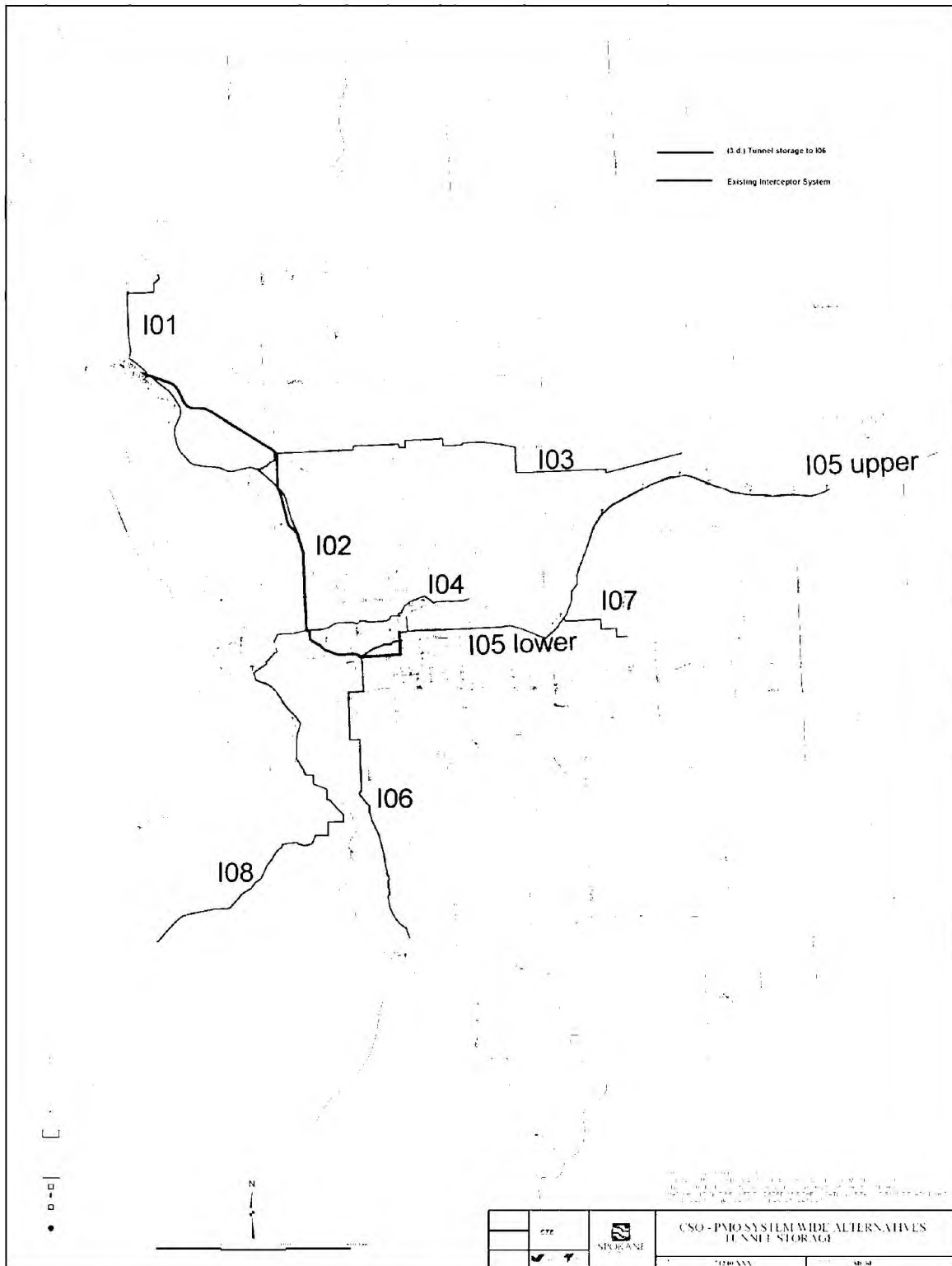
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Chapter 3: Screening Criteria and Screening Process

This chapter describes the screening criteria and process used to reduce the list of 67 system-wide alternatives to a selected list of alternatives subject to refined analysis and evaluation. In the next chapter, the screening criteria are applied through the screening process to select alternatives for refined analysis and evaluation.

3.1 Screening Criteria

The screening criteria used to evaluate and rank the system-wide alternatives are listed in **Table 3-1**. This table also provides a description of the development of a relative numeric value for each criterion.

Table 3-1 Screening Criteria for System-wide CSO Alternatives

Type of Criteria	Criteria	Definition of Scoring for Particular Criteria		
PRIMARY	Quantitative			
	Net Present Value	Pro-rated by ratio with the lowest net present value (NPV).		
	Water Quality	Pro-rated by the CSO TSS loading to the Spokane River and Latah Creek.		
SECONDARY	Qualitative			
	Functionality	Good Score	Average Score	Fair Score
		Reliability: System requires O&M activity similar to existing program and has a reliable history in other municipalities.	Reliability: Requires some increased effort and special considerations	Reliability: Substantial and new O&M required (highly complex and frequent operation or difficult cleaning).
		Land required: No land required outside City Right of Way.	Land required: Requires some additional land acquisition or change of existing land use (city property).	Land required: Requires substantial land acquisition or change of existing land use (city property).
	Environmental	Odor & Noise: Minimal concern for bad odors or loud noise.	Odor & Noise: Some concern for bad odors, loud noise.	Odor & Noise: Severe concern for bad odors and loud noise.
		Slopes/Shoreline/Threatened Species: Minimal concern for slope stability, shorelines, wildlife habitat, or wetlands (Ecology permit approval).	Slopes/Shoreline/Threatened Species: Some concern for slope stability, shorelines, wildlife habitat, or wetlands.	Slopes/Shoreline/Threatened Species: Severe concern for slope stability, shorelines, wildlife habitat, or wetlands.
	Neighborhood Acceptability	Alternative fits well into Neighborhood Plan (location, aesthetics, or amenities).	Causes minor disruption to neighborhood (buildings, or parks).	Causes major disruption to neighborhood (buildings, or parks).
	Constructability	Requires routine and reasonable construction methods.	Has some difficult construction methods required (utility conflicts).	Requires very difficult construction methods (site constraints, dewatering, rock excavation, or steep slopes).

3.1.1 Primary Category Screening Criteria

The primary category screening criteria are quantitative criteria that can be determined through direct calculation. For all primary category screening criteria, all alternatives received a score between 1 and 10 based on calculations defined below. Alternatives with higher scores (approaching or including 10) can be considered "better" alternatives.

These primary category criteria are listed and further defined in the following:

- Net Present Value (NPV) Cost. NPV costs are the sum of the estimated capital cost (2003 \$s) and the present value of an estimated annual operation and maintenance (O&M) cost series (2003 \$s). Capital costs include those for design, property acquisition, construction (w/ a contingency), and construction management activities. The value for the NPV cost criterion is based on assigning the numeric value of 10 to the alternative with the lowest NPV. Subsequent values are calculated for the other alternatives by dividing the lowest NPV cost by the respective alternative's NPV cost and then multiplying this ratio by 10.
- Water Quality. A value for water quality is based upon the projected total suspended solids (TSS) load to the Spokane River generated by CSOs following implementation of a given alternative. This is derived from the application of a "typical year" of rainfall which is defined in the internal memorandum *Average Precipitation Year Preparation* (February 8, 2002). This memorandum is included in the Appendix. A value for the water quality criterion is based on assigning the numeric value of 10 to the alternative with the lowest TSS loading to the Spokane River. Subsequent values are calculated for other alternatives by dividing the lowest TSS loading by the respective alternative's TSS loading and then multiplying this ratio by 10.

3.1.2 Secondary Category Screening Criteria

The secondary category screening criteria represent qualitative criteria that address site-specific conditions. For all secondary category screening criteria, all alternatives were assigned a score between 1 and 10 based on a perception of the impact of a given alternative. A high score (approaching or including 10) indicates a more positive perception. Therefore, alternatives with higher scores can be considered having positive significance or having greater acceptance.

These secondary category criteria are listed and further defined in the following:

- Functionality. Functionality is intended to reflect the reliability of the technology associated with an alternative with emphasis on complexity of operation and maintenance. It also includes the impact of land needs that may be required outside of City ownership.
- Environmental. Environmental is intended to address additional odor and noise that would be associated with a particular alternative and then to address all other biological or habitat issues.
- Neighborhood Acceptability. Neighborhood Acceptability is intended to address the impact or degree of disruption that a given alternative would have on a neighborhood during both construction and ongoing use.
- Constructability. Constructability is intended to characterize the type of construction methods that most likely would be used for a particular alternative.

3.2 Weight of Screening Criteria

Equal weight was applied to the NPV cost criterion rating and to the average of all of the remaining, non-monetary criteria ratings (including water quality). In this approach, the combined non-monetary criteria receive equal weight when compared to cost. A summary rating for each alternative was determined by adding the NPV cost criterion rating to the average of the non-monetary criteria ratings and then dividing by 2.

3.3 Guidelines for Application of the Screening Criteria

The following guidelines were established to provide a consistent basis for the assignment of numeric values to the secondary category, criteria:

- **Functionality.** Functionality addresses the reliability with respect to unique or new technologies. For example, a new technology may be assigned a lesser numeric value due to its lack of widespread or long-term implementation or familiarity among City O&M staff. Conversely, any alternative that requires additional, but common, facilities, such as pumps would not be assigned a lower numeric value because pumps are normal or common technology with which the City has extensive experience. Any additional costs associated with typical or common technology would be accounted for through the net present value cost primary screening criterion, which would account for additional staffing needs and ongoing O&M.

In addition, the functionality criterion addresses the need to acquire land outside existing City right-of-way or ownership. Conveyance projects would score high, while tunnel or very large storage facilities would score lower. Conventional storage facilities would likely score somewhere in between to reflect the larger scale impact on land during construction and then ongoing use and to reflect the need to provide greater levels of operation and maintenance activity for storage facilities when compared to conveyance facilities.

- **Environmental.** Environmental is assigned values based on the additional impact an alternative would have on the environment, including an alternative's potential to generate odor or noise; to impact sensitive areas (e.g., steep slopes); to effect nearby shoreline; to impact wildlife; or to impact threatened species (e.g., salmonid spawning). For example, for any flows conveyed directly to treatment plants, scoring is based on the additional odor or impact from wet weather facilities and wet weather flows only, not from the overall treatment plant.
- **Neighborhood Acceptability.** The scoring for Neighborhood Acceptability is based on an alternative's potential to provide amenities to neighborhoods and avoid impact to existing development or historic areas.
- **Constructability.** The scoring for Constructability is based on whether typical or standard construction methods can be used. Tunnels, larger storage facilities, river crossings, and deep conveyance would most likely require special construction methods and were scored lower.

In addition, for any alternative that considered diversion and conveyance of additional combined sewer flows to a wastewater treatment plant, it was assumed that the wastewater treatment plant already exists. The numeric value to be assigned to any management of wet weather flows conveyed to the wastewater treatment plant should address the character of the additional facilities needed for wet weather flow management and the related impact from wet weather flows only. In all cases, the wastewater treatment plant was assumed to be typical secondary-level wastewater treatment plant with limited provisions for treating or managing wet weather flows. Therefore, to provide for wet weather flows, a large storage facility and associated pump station would be required.

3.4 Ongoing Application of the Screening Criteria

These screening criteria and the screening process described herein are applied at each screening step. Specifically, they are applied to assist in the selection of the final alternatives to be subjected to a detailed evaluation; and again applied to assist in the identification of a recommended final alternative. The final alternative is represented by an updated CSO reduction Capital Improvement Program (CIP).

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Chapter 4: Results of Initial Screening Process □ Selection of Refined System-wide CSO Reduction Alternatives

In this chapter, the application of the screening criteria, as defined and described in Chapter 3, to the 67 system-wide alternatives is presented. The goal of this screening and subsequent evaluation process is to select alternatives for further, detailed evaluation using the interceptor model to provide a greater level of confidence as to the required CSO reduction facilities and their associated costs. In all cases, the basis for all evaluations was flow Scenario 6 (2020 □ Wet Weather with SCWTP).

4.1 Initial Screening of System-wide Alternatives

By elimination of remote treatment (discussed in Chapter 2), and the highest NPV cost alternatives, the 67 system-wide alternatives were reduced to fourteen (14). Further examination of these 14 system-wide alternatives indicated substantial similarities between some of the alternatives. This enabled the consolidation of the 14 system-wide alternatives to 10. Screening criteria were then applied. Numerical values were assigned by CSO PMO and City staff to each criterion for each alternative and then averaged across all alternatives to yield a total score. These ten system-wide alternatives, and their associated costs and scoring, are presented in detail in **Table 4-1**. The basis for defining the scores given in this table was defined or described in Chapter 3. The basis for the cost estimates given in this table was given in Chapter 2, where all listed costs are for wet weather only facilities and include engineering, construction management, administration, and contingency. The current TSS loadings to the Spokane River under the current baseline conditions is 187,000 pounds per year, which can be compared to the reduced annual total TSS loadings listed under each alternative in **Table 4-1**.

A description of the ten initially screened system-wide alternatives and their respective screening weighted scores follows:

- Alternative 1.e.iii. This alternative proposes separation of CSO Basins 15 and 41, diversion of dry weather and wet weather flows to a new wastewater treatment plant located in the eastern portion of the City of Spokane, and storage for all other CSO basins and at RPWRF. The assumed annual average capacity of the new treatment plant was 31 mgd, at the time of this analysis. This 31 mgd consisted of Spokane valley flow rates exceeding the current contractual value between the City of Spokane and the County of Spokane and all City of Spokane flow rates from CSO Basins 33, 34, 38, 39, and 40 conveyed to a □regional□ wastewater treatment plant via parallel piping. For this alternative, all flows conveyed to the new wastewater treatment plant are assumed to receive full secondary treatment (CSO is stored and then conveyed through the wastewater treatment plant). It should be noted that this alternative has received considerable attention from other agencies and the City of Spokane and has been subsequently modified a number of times with respect to the various flow rates that could be diverted to a □regional□ wastewater treatment facility. In Chapter 6, the most current approach to sizing and utilizing such a □regional□ facility is described.

This alternative represents the least cost alternative and has a weighted score of 7.9.

- Alternative 1.e.i. This alternative proposes separation of CSO Basin 41, diversion of dry weather and wet weather flows to a new wastewater treatment plant located in the western portion of the City of Spokane, and storage for all other CSO basins and at RPWRF. The assumed annual average capacity of the new treatment plant was 44 mgd, at the time of this analysis. This 44 mgd consisted of the interception and conveyance via parallel piping of all South Hill and Spokane Valley (County and City of Spokane Valley) wastewater flows. This alternative also assumed full secondary treatment of all flows conveyed to the new wastewater treatment plant.

This alternative has a weighted score of 7.3.

Table 4-1 Detailed Description of Ten, Initially Screened System-wide CSO Reduction Alternatives

Evaluation Criteria		1	2	3	4	5	6							
Description	(Old I.D. Number)	Eastside Advanced Wastewater Treatment Plant (a)	Westside Advanced Wastewater Treatment Plant (a)	Reroute of Portion of I06 Wet Weather Flows to New I03 Storage	Storage to Provide Interceptor Conveyance (I02&I04)	Storage for All CSO Basins Except Separate CSO Basin 41	Reroute Flows from CSO 6, 7, 10 & I03 to Provide Interceptor Conveyance (I02)	Reroute Flows in I08 to SAWTP to Provide Interceptor Conveyance Capacity (I02)	Convey Wet Flows from I02, I04, I06, I05 slower, & I07	Divert I03, CSO 6, 7, and 10 with In-line Storage to SAWTP				
		(1 a.iii)	(1 a.ii)	(1 d.ii)	(1 a.ii)	(2 a.)	(3 a.)	(1 b.vi)	(1 b.ii)	(1 a.iii)	(3 a.)			
PRIMARY Factors	Conveyance Cost: Capital + PV (million \$)	\$18.4	\$48.2	\$28.5	\$6.3	\$6.0	\$6.0	\$13.2	\$14.0	\$30.1	\$40.4			
	Added Interceptor Lengths (ft) =	12,700	26,500	4,500	700	0	0	10,000	26,340	27,815	9,000			
	SAWTP Storage Cost: Capital + PV O&M (million \$)	\$3.2	\$1.7	\$24.9	\$22.8	\$10.3	\$17.1	\$21.9	\$45.2	\$46.4	\$21.3			
	SAWTP Storage size (million gallon) =	1.5	0.8	11.8	10.8	4.9	8.1	10.4	21.4	22.0	10.1			
	SAWTP Peak inflow (million gallon/day) =	137	149	134	139	146	142	142	144	166	146			
	Basin Storage Cost: Capital + PV O&M (million \$)	\$60.7	\$15.0	\$104.8	\$134.9	\$157.1	\$146.7	\$133.2	\$112.9	\$110.2	\$130.8			
	Number of Storage Facilities =	14	7	16	19	18	19	19	17	19	16			
	Basin Storage Total (million gallon) =	23.2	5.4	42.6	55.3	64.2	60.3	64.8	46.9	45.3	53.9			
	Unregulated Wet Flow Storage Cost: PV (million \$)	\$0.0	\$0.0	\$9.4	\$9.4	\$0.0	\$9.4	\$7.0	\$9.4	\$9.4	\$7.0			
	Separation Cost: Capital + PV O&M (million \$)	\$2.7	\$2.7	\$5.8	\$2.7	\$5.8	\$2.7	\$5.8	\$5.8	\$2.7	\$2.7			
	New Treatment Plant Cost: Capital+PV O&M (million \$)	\$57.0	\$80.0											
Alternative Net Present Value, NPV (million \$)		\$192	\$203	\$233	\$236	\$239	\$243	\$243	\$251	\$268	\$273			
SCORING	Good ●	Average ●	Far ○											
NPV Score	10	5	1	7	10	9	5	5	4	4				
Water Quality (4)	10	5	1	1	10	10	10	10	10	10	10			
SECONDARY Factors	Functionality (3)	Reliability: System requires O&M activity similar to existing program and has a reliable history in other municipalities.	Reliability: Requires some increased effort and special considerations	Reliability: Substantial and new O&M required (highly complex and frequent operation or difficult cleaning).	7.5	8.1	5.9	5.1	4.0	4.3	5.8	5.3	5.8	5.0
		Land required: No land required outside City Right of Way.	Land required: Requires some additional land acquisition or change of existing land use (city property).	Land required: Requires substantial land acquisition or change of existing land use (city property).	5.4	6.1	5.2	4.4	3.6	4.1	4.2	4.2	5.7	4.9
	Environmental (4)	Odor & Noise: Minimal concern for bad odors or loud noise.	Odor & Noise: Some concern for bad odors, loud noise.	Odor & Noise: Severe concern for bad odors and loud noise.	6.3	7.8	6.4	5.3	3.8	4.5	5.1	4.7	4.7	4.5
		Slopes/Shoreline/Threatened Species : Minimal concern for slope stability, shorelines, wildlife habitat, or wetlands (permit approval).	Slopes/Shoreline/Threatened Species : Some concern for slope stability, shorelines, wildlife habitat, or wetlands.	Slopes/Shoreline/Threatened Species : Severe concern for slope stability, shorelines, wildlife habitat, or wetlands.	7.0	6.4	6.3	5.3	4.8	5.3	5.1	3.7	5.8	4.0
	Neighborhood Acceptability: Amenities, Historic Areas,	Alternative fits well into Neighborhood Plan (location, aesthetics, or amenities).	Causes minor disruption to neighborhood (buildings, or parks).	Causes major disruption to neighborhood (buildings, or parks).	6.3	5.6	5.6	4.7	3.9	3.8	3.9	4.4	4.3	4.7
Constructability	Requires routine and reasonable construction methods.	Has some difficult construction methods required (utility conflicts).	Requires very difficult construction methods (site constraints, dewatering, rock excavation, or steep slopes).	5.7	5.1	6.5	5.7	6.6	5.5	4.6	3.7	4.9	4.0	
Weighted Average Score:		7.9	7.3	5.4	4.8	4.4	4.2	4.3	3.6	3.0	2.9			
Comment - Accept/Reject		Selected for more evaluation	Not selected due to location	Selected for more evaluation	Selected for more evaluation	Combined with 3.c. (similar)	Combined with 2.a. (similar)	Selected for more evaluation	Selected for more evaluation	Not selected	Added as an option on 1.b.vi			

- (1) Pro-rated by ratio with the lowest present value. These estimated costs are order of magnitude in nature, and Net Present Value includes engineering, construction management, administration, property acquisition and construction (w/ contingency)
- (2) Pro-rated by CSO loading reduced.
- (3) All alternatives are presumed to meet minimum treatment standards as defined in Criteria for Sewage Works Design (Ecology, 1998).
- (4) All alternatives are presumed to meet regulatory compliance through CSO Design Event evaluation and long term simulation for an average of one overflow per year per outfall.

- x Alternative 1.d.ii. This alternative proposes the diversion of a portion of I06 Wet Weather flows to I08 storage in combination with storage in the remaining CSO basins and at RPWRF. Unregulated wet weather flows from interceptor segments I03, I04 and I05 (Post Street) were also stored.

This alternative has a weighted score of 5.4.

- x Alternative 1.a.ii. This alternative proposes storage in CSO Basins 6, 7, 10, 12, 15, 23, 24, & 26 sufficient to create conveyance capacity in the existing interceptor with subsequent storage at RPWRF. Unregulated wet weather flows from interceptor segments I03, I04 and I05 (Post Street) were also stored.

This alternative has a weighted score of 4.8.

- x Alternative 2.a. This alternative proposes separation for CSO Basins 15 and 41 and storage for all remaining CSO basins and at RPWRF.

This alternative has a weighted score of 4.4.

- x Alternative 3.c. This alternative proposes separation for CSO Basin 41 and storage for all remaining CSO basins and at RPWRF. Unregulated wet weather flows from interceptor segments I03, I04 and I05 (Post Street) were also stored.

This alternative has a weighted score of 4.2.

- x Alternative 1.b.vi. This alternative proposes separation for CSO Basins 15 and 41 and then storage and rerouting of equalized combined flows from CSO Basin 6, 7, 10 and the unregulated flows from interceptor I03, so that sufficient conveyance capacity is created in the existing interceptor. The remaining CSO basins have provisional storage depending on downstream interceptor conveyance capacity and storage is provided at RPWRF.

This alternative has a weighted score of 4.3.

- x Alternative 1.b.ii. This alternative proposes to convey combined flows in I08 via a pump station/force main. The remaining CSO Basins are stored with exception of CSO Basins 15 and 41, which are to be separated. Unregulated wet weather flows from interceptor segments I03, I04 and I05 (Post Street) were also stored.

This alternative has a weighted score of 3.6.

- x Alternative 1.a.iii. This alternative proposes separation for CSO Basins 15 and 41, to convey wet weather flows along I02, I04 and I05 lower, and then providing sufficient storage in the following □CSO Basins 6, 7, 10, 12, and 15 (I02); CSO Basins 16, 25, and 22 via I08 (I02); CSO Basins 23 (I04); CSO Basins 24, and 26 via I06 (I05); and CSO Basins 33 and 34 (I05) ⊥ to optimize conveyance in the existing interceptor and minimize new interceptor facilities. Storage is provided at all remaining CSO basins and at RPWRF.

This alternative has a weighted score of 3.0.

- x Alternative 3.a. This alternative proposes separation for CSO Basin 41, to provide in-line storage from RPWRF headwork□ to the I03 interceptor junction, where flows from CSO Basins 6, 7, 10 and unregulated flow from I03 would be stored in this in-line storage facility. Storage would be provided for the remaining CSO basins and at RPWRF. Unregulated wet weather flows from interceptor segments I04 and I05 (Post Street) were also stored.

This alternative has a weighted score of 2.9.

As noted previously, equal weight was applied to the NPV cost score and to the average of the non-monetary plus the TSS criteria scores, which was completed for all alternative scoring.

4.2 Selection of System-wide Alternative for Detailed Analysis

Based on the scoring applied to the 10, initially screened system-wide alternatives, six alternatives with the highest weighted scores were selected for further, detailed analysis. A discussion of this selection process is presented as follows:

- x Alternative 1.c.iii. With the highest weighted score of 7.9, it was decided to advance this alternative. For clarification purposes, this alternative is re-designated as **Alternative 1: Eastside Advanced Wastewater Treatment Plant**. This has previously been denoted as SCWTP.
- x Alternative 1.e.i. Although this alternative had a high weighted score of 7.3, the alternative was discounted due to the major diversion of wastewater flows away from the existing RPWRF. It does not represent a viable regional solution to wastewater needs principally because of the proposed location. It was agreed to eliminate this alternative from further consideration.
- x Alternative 1.d.ii. With a high weighted score of 5.4, it was decided to advance this alternative. This alternative is re-designated as **Alternative 2; Reroute of Portion of I06 Wet Weather Flows to New I08 Storage**.
- x Alternative 1.a.ii. This alternative had a high weighted score of 4.8. The original concept proposed increasing conveyance capacity along interceptor segments I02 and I04 between the RPWRF headworks and the intersection of I06 with I05. As a result of discussion regarding the cost differences between adding conveyance capacity to the interceptor system and installing storage, it was agreed to advance this alternative. In conjunction with this alternative the PMO will investigate the potential to expand the conveyance improvements in order to provide a refined analysis comparing conveyance verses storage cost. This alternative is re-designated as **Alternative 3; Storage to Provide Interceptor Conveyance Capacity (I02 & I04)**.
- x Alternative 2.a. This alternative had a relatively high weighted score of 4.4. It is very similar to Alternative 3.c. This is discussed under the next alternative below.
- x Alternative 3.c. This alternative had a relatively high weighted score of 4.2. Because of the similarity to Alternative 2.a. (discussed above), it was agreed to combine the two into one alternative and advance this alternative while examining the differences as variations of the base alternative. This alternative is re-designated as **Alternative 4; Storage for All CSO Basins except Separate CSO Basins 15 & 41**.
- x Alternative 1.b.vi. With a relatively high weighted score of 4.3. It was decided to advance this alternative. This alternative is re-designated as **Alternative 5; Reroute Flows from CSO Basins 6, 7, & 10 and from I03 to Provide Interceptor Conveyance Capacity (I02)**.
- x Alternative 1.b.ii. With a relatively high total score of 3.6, it was decided to advance this alternative. This alternative is re-designated as **Alternative 6; Reroute Flows in I08 to RPWRF to Provide Interceptor Conveyance Capacity (I02)**.
- x Alternative 1.a.iii. With a low weighted score of 3.0, it was decided not to advance this alternative.
- x Alternative 3.a. Although this alternative had a low weighted score of 2.9, it was agreed to consider this as a variation to Alternative 5 (re-designated Alternative 1.b.vi.) and not be considered as a separate alternative.

Table 4-2 summarizes the costs and scoring for the 6 selected system-wide CSO reduction alternatives, where all listed costs are for wet weather only facilities. Schematics of these six alternatives are given in **Figures 4-1** thru **Figure 4-6**.

In the next Chapter, these 6 selected system-wide CSO reduction alternatives will be analyzed in greater detail in order to provide a basis for selecting a preferred system-wide CSO reduction alternative. This greater detail will include cost breakdowns and listing of all scoring data.

Table 4-2 Summary of Six, Selected System-wide CSO Reduction Alternatives (Wet Weather Costs)

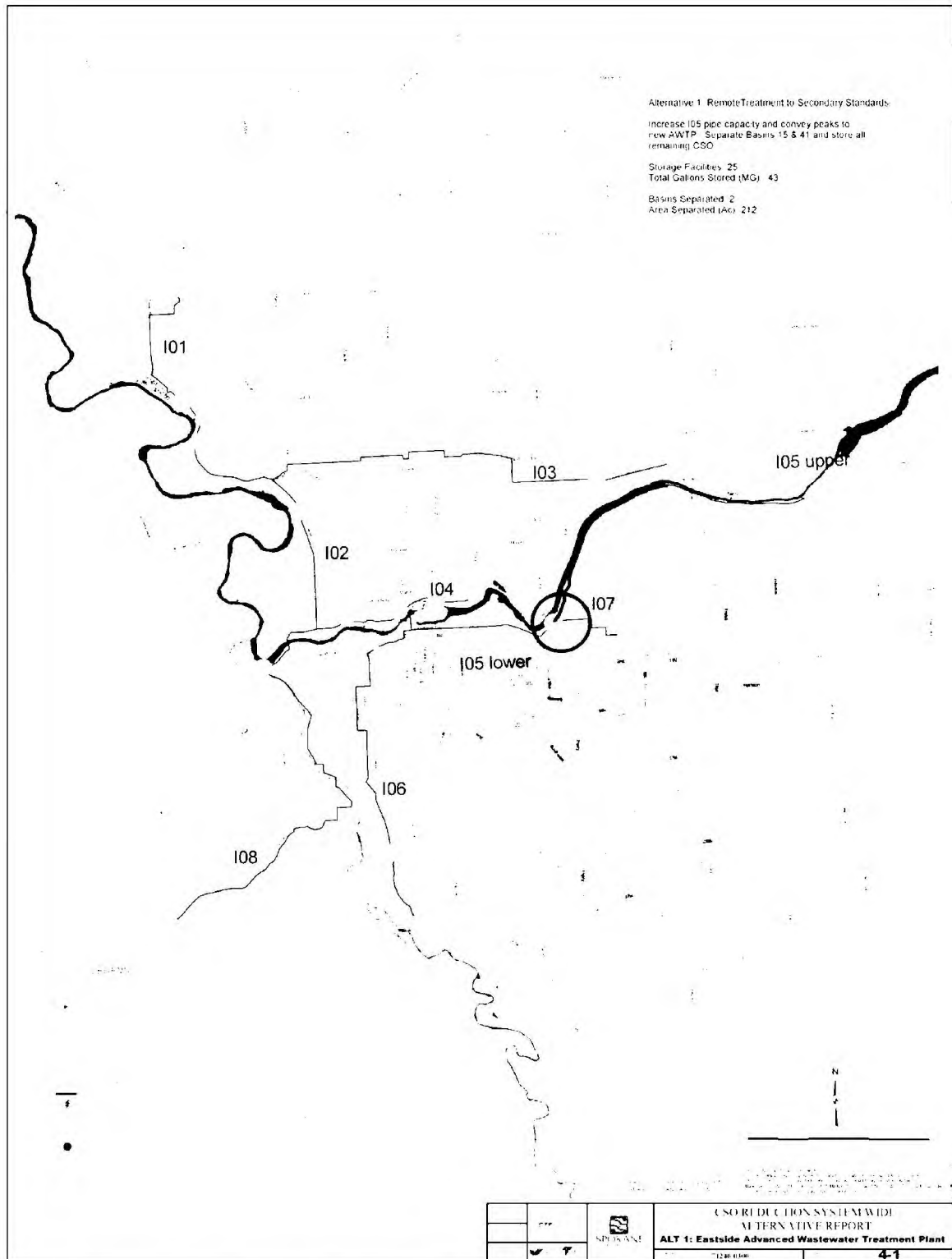
Name	Alternative					
	1	2	3	4	5	6
	Eastside Advanced Wastewater Treatment Plant	Reroute of Portion of I06 Wet Weather Flows to New I08 Storage	Storage to Provide Interceptor Conveyance Capacity (I02 & I04)	Storage for All CSO Basins Except Separate CSO Basins 15 & 41	Reroute Flows from CSO Basins 6, 7, & 10 and from I03 to Provide Interceptor Conveyance Capacity (I02)	Reroute Flows in I08 to RPWRF to Provide Interceptor Conveyance Capacity (I02)
Old ID Number (See Table 3-2)	1.c.ii.	1.d.ii.	1.a.ii.	2.a. + 3.c.	1.b.vi.	1.b.ii.
Net Present Value (NPV) (\$million)	192	233	236	243	243	251
Weighted Score	7.9	5.4	4.8	4.2	4.3	3.6

Note: NPV cost is in terms of 2003 dollars.

1994 CSO Reduction Plan Comparisons

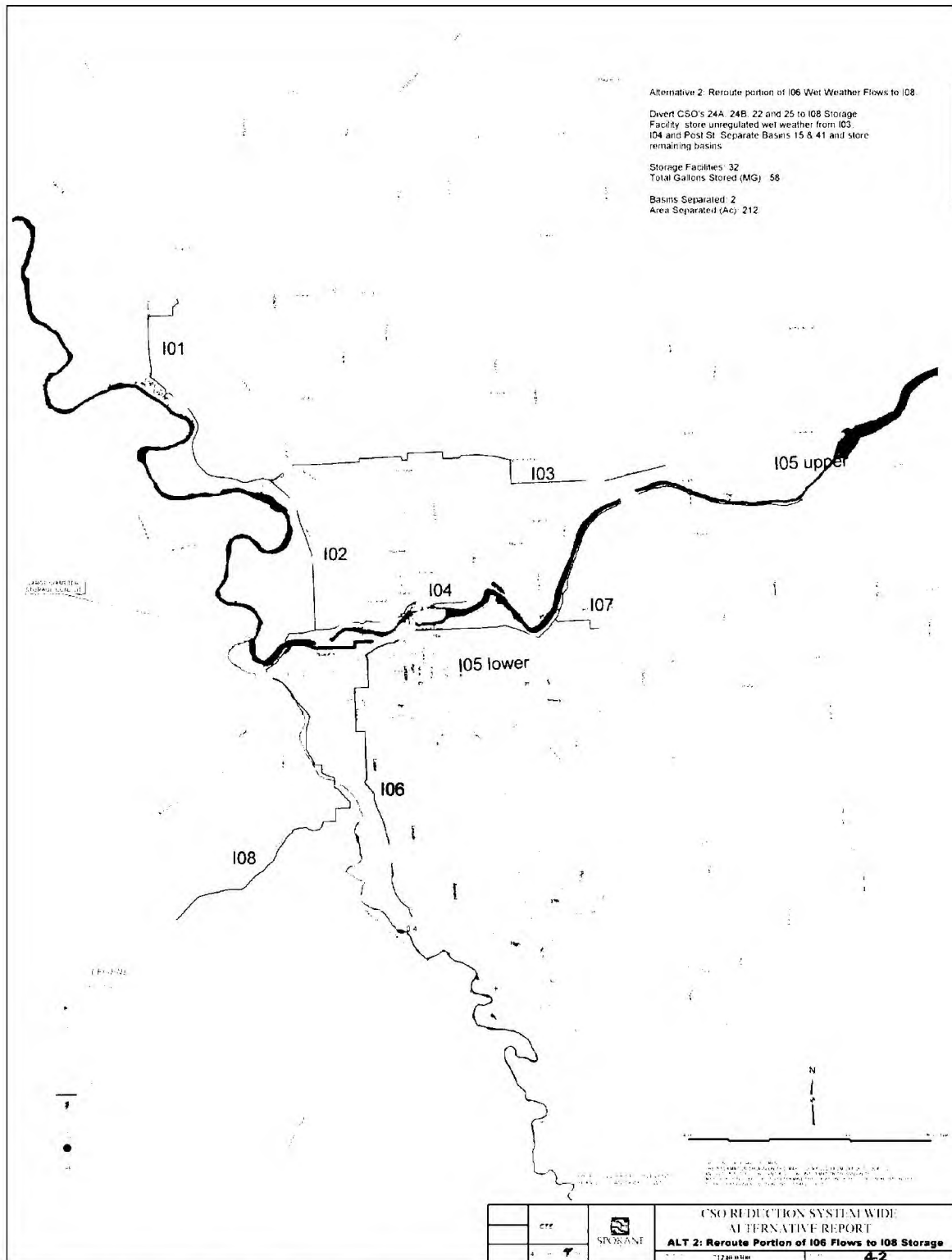
The 1994 CSO Reduction Plan preferred alternative consisted of detention storage coupled with existing capacity optimization. The capacities of storage and conveyance facilities were based upon the application of a historical storm. (June 12, 1992). The return frequency of this storm was estimated to be a 1.2 year. The alternative's facilities were adjusted to address increased flow rates generated by the application of the CSO Design Event (2 year return frequency). The CSO Design Event provides a 97% probability that the CSO regulations will be satisfied when overflows are averaged over a 5 year period. The simulation results increased the need for storage by approximately 400% (17.6 mg to 71.2 mg).

Through the application of the costs described in Chapter 2 (Section 2.4) a comparative NPV was developed. The NPV for the 1994 preferred alternative was estimated to be \$294 million. This estimate exceeded the ten initially screened system wide alternatives (**Table 4-1**).



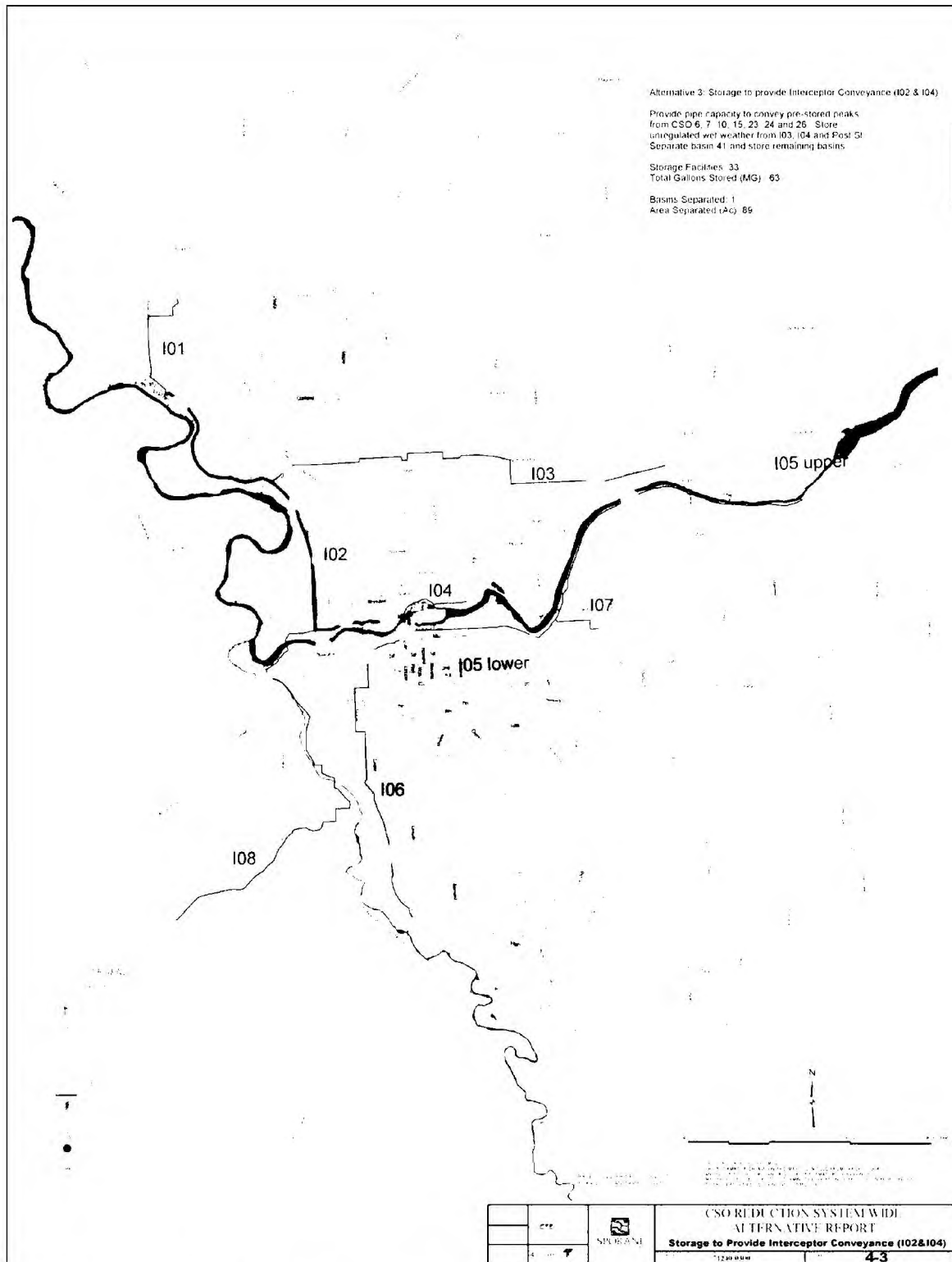
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12/23/2005



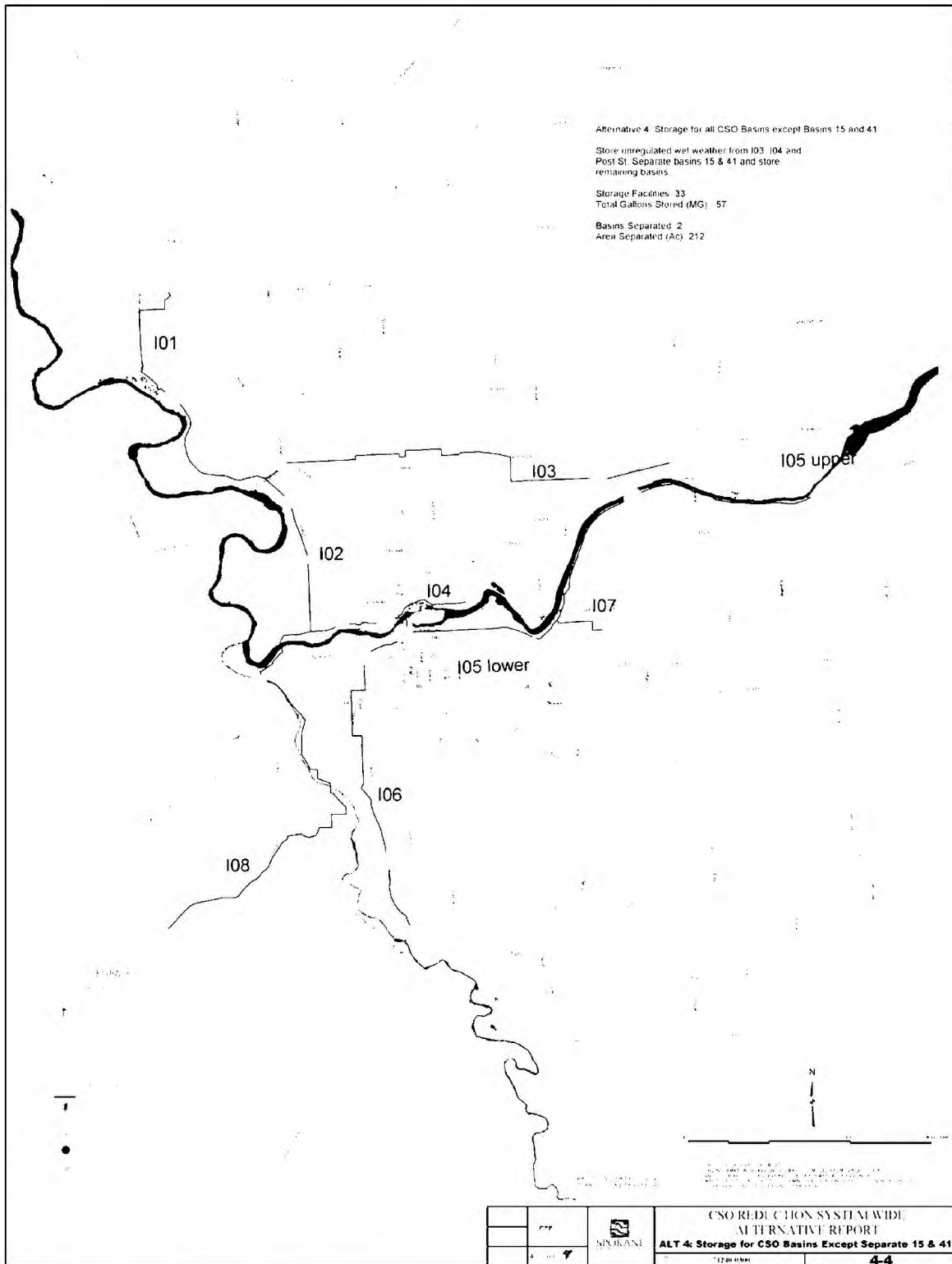
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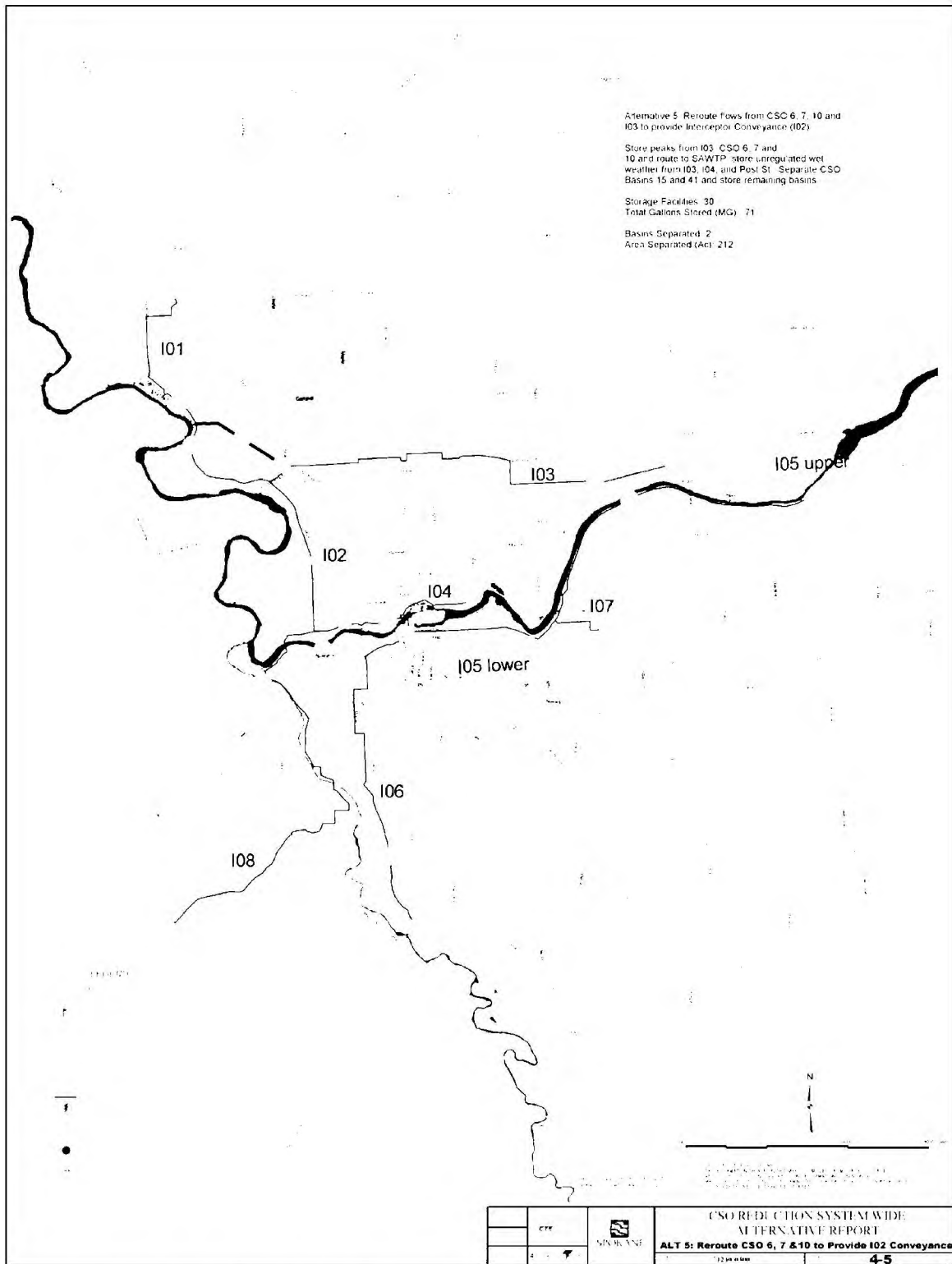
Combined Sewer Overflow Reduction System Wide Alternative Report
4-8

12/23/2005



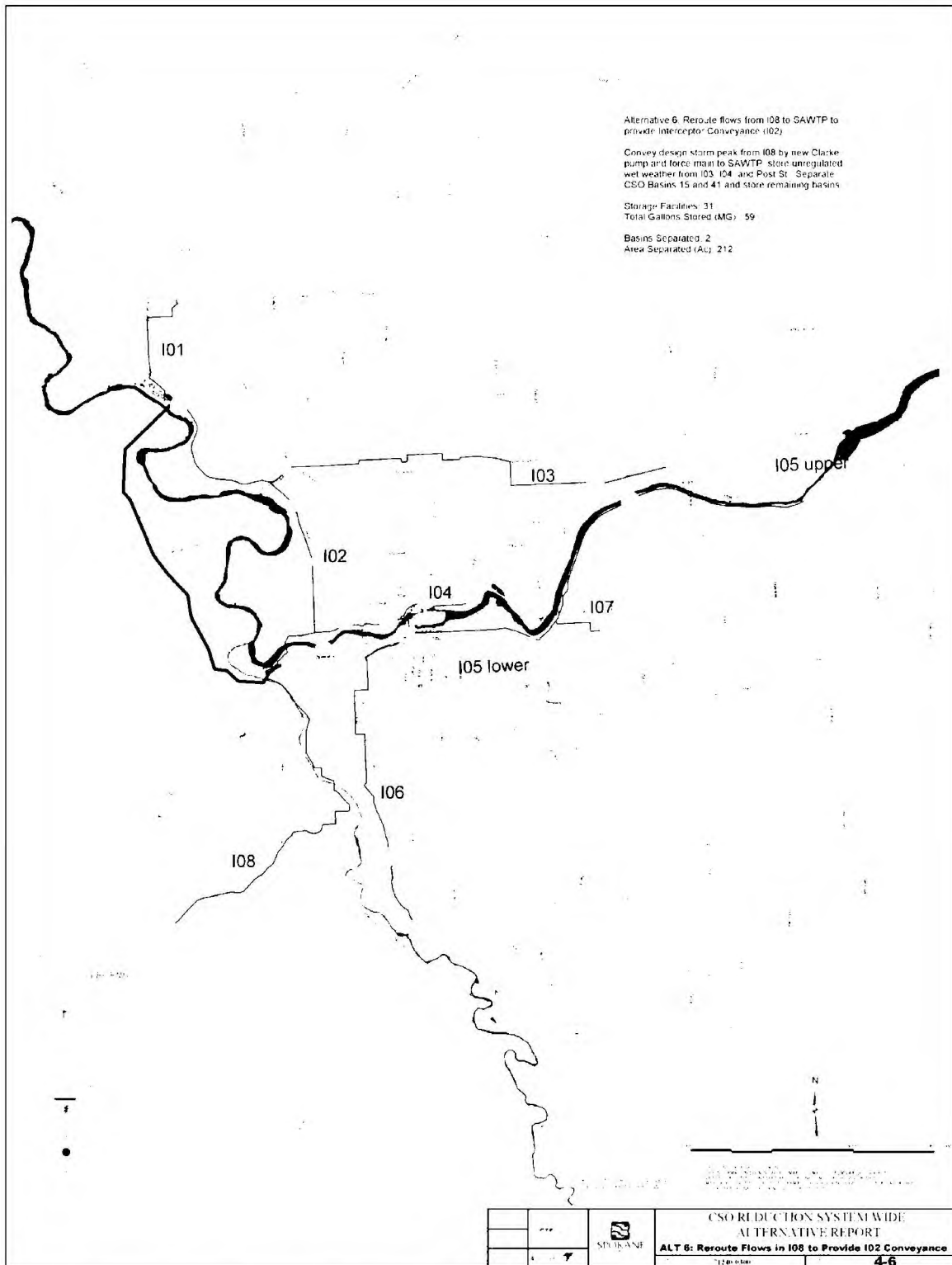
Combined Sewer Overflow Reduction System Wide Alternative Report
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Chapter 5: Evaluation of Refined System-wide CSO Reduction Alternatives

This chapter describes the evaluation of the six selected system-wide CSO reduction alternatives. This includes model development, cost estimating, and comparative evaluation. This provides the basis for the selection of a recommended system-wide CSO alternative, as detailed in the next chapter.

5.1 Refined System-wide Alternative Development

Due to additional flow monitoring data and information obtained from the City Sewer Maintenance department which include Hansen manhole and pipe updates and standard, ongoing field inspection activities the existing system-wide model was updated and recalibrated for CSO basins 6, 12, 16a, 22b, 25, 26, 39, and interceptor segment I03.

In order to represent proposed facility performance, the updated and recalibrated XP-SWMM system-wide model was refined and updated to represent each of the six screened alternatives.

5.1.1 Refined System-wide Alternative Model Development Approaches

In addition to following the assumptions and approaches listed in Chapters 1 and 2, the following approaches were applied when developing the refined models:

- x Storage facilities are modeled as gravity-fed storage nodes.
- x Potential flooding generated through the application of the design storm was mitigated through distributed detention storage or relief sewers in model segments where simulated flooding occurred longer than 30 minutes. The selection of 30 minutes is arbitrary. The hypothetical improvements did not extend to or through load points. Flooding at load points could be a modeling artifact caused by a large tributary area's load being applied to a single system manhole or pipe segment. The City does not have extensive complaint information or flow monitoring to provide definitive closure to this issue. These conditions are being investigated further and modifications to CSO reduction facility size or conveyance needs, if needed, will be implemented at that time.
- x Preliminary site locations for storage facilities, distributed storage and combined storage have been incorporated into the models.
- x Any wet weather flows conveyed to a new wastewater treatment plant are assumed to be equalized to a level that all wet weather flows received full secondary treatment.

5.1.2 Refined System-wide Alternative Model Simulations

As stated throughout this report, to determine CSO reduction facility needs for each alternative, the CSO Design Event, as defined in the technical memorandum *Precipitation and Snowmelt Analyses and CSO Design Event Development for CSO Reduction Alternative Evaluation* (CTE Engineers, Feb 2002), was applied to the updated models. The flow scenario that was applied was Scenario 6 (2020 11 Wet Weather with SCWTP)

The CSO Design Event simulation results for each of the system-wide alternative models were compiled and utilized to estimate CSO reduction facility costs for each alternative.

5.2 Refined Cost Estimates

A summary of the cost estimates for the refined system-wide alternatives is given in **Table 5-1**, based on the cost assumptions given in Chapter 2. In addition to these assumptions, the wet weather facility costs reflect a refined analysis, facility size, and basis of cost. The costs include design engineering and construction management (CM) (25% of the construction cost); and a contingency (15% of the construction cost).

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Table 5-1 Estimated Costs for Six Refined System-wide CSO Reduction Alternatives

Alternative	1	2	3	4	5	6
Name	Eastside Advanced Wastewater Treatment Plant	Reroute of Portion of I06 Wet Weather Flows to New I08 Storage	Storage to Provide Interceptor Conveyance Capacity (I02 & I04)	Storage for All CSO Basins Except Separate CSO Basins 15 & 41	Reroute Flows from CSO Basins 6, 7, & 10 and from I03 to Provide Interceptor Conveyance Capacity (I02)	Reroute Flows in I08 to RPWRF to Provide Interceptor Conveyance Capacity (I02)
Old ID Number (See Table 3-2)	1.e.ii.	1.d.ii.	1.a.ii.	2.a. + 3.c.	1.b.vi.	1.b.ii.
Collection System Improvements for Wet Weather						
Construction (\$million)	132	166	179	162	173	170
Design, CM & Contingency (at 40%) (\$million)	53	67	72	65	69	68
Property Cost (\$million)	8	10	11	18	11	10
Capital Subtotal (\$million)	193	243	262	245	253	248
O&M NPV (\$million)	18	20	21	21	20	21
Subtotal NPV (\$million)	211	263	283	266	273	269
Treatment Facility Improvements for Dry and Wet Weather						
Secondary Treatment Capital - SCWTP (\$million)	55	0	0	0	0	0
Secondary Treatment Capital - RPWRF (\$million)	35	51	51	51	51	51
Total NPV (\$million)	301	314	334	317	324	320
Total NPV Score	10	6.5	1	5.6	3.7	4.8

These costs include property acquisition estimates and an estimate of the treatment facility costs associated with dry and wet weather. Treatment facility costs for Alternative 1 represent a preliminary estimate of the incremental dry and wet weather costs applied to the City, to implement a regional eastside advanced wastewater treatment plant. Facility costs for an equally capable facility implemented by the City would increase these costs \$25 million to \$30 million. **Table 5-1** includes costs of required dry weather treatment facilities added to the wet weather only facility costs. This provides a basis for assessing the total cost and impact of a particular system-wide CSO reduction alternative. The capital costs include all expenditures incurred to support the construction of the facilities. No significant additional operation and maintenance costs are expected to support these additional treatment facilities.

In order to better differentiate NPV cost criterion values for these alternatives, the following methodology was utilized. The values for the criterion were determined by first assigning a numeric value of 10 to the alternative with the lowest NPV. Similarly, a numeric value of 1 was assigned to the highest NPV. Then intermediate values were calculated for the remaining alternatives by establishing a prorated value between the two set values.

5.3 Application of Screening Criteria to the Six Refined CSO Reduction Alternatives

Following the CSO Design Event application to the updated and refined system-wide CSO reduction alternative models, the screening criteria and process, (described in Chapter 3), was applied by CSO PMO and City staff to the six refined alternatives. As described earlier for the initial screening, equal weight was applied to the NPV cost score and to the average of the non-monetary plus the TSS criteria scores. The results of this scoring are shown in **Table 5-2**.

Table 5-2 Non-Monetary Scoring for Six Refined System-wide CSO Reduction Alternatives

Alternative	1	2	3	4	5	6
Name	Eastside Advanced Wastewater Treatment Plant	Reroute of Portion of I06 Wet Weather Flows to New I08 Storage	Storage to Provide Interceptor Conveyance Capacity (I02 & I04)	Storage for All CSO Basins Except Separate CSO Basins 15 & 41	Reroute Flows from CSO Basins 6, 7, & 10 and from I03 to Provide Interceptor Conveyance Capacity (I02)	Reroute Flows in I08 to RPWRF to Provide Interceptor Conveyance Capacity (I02)
Old ID Number (See Table 3-2)	1.e.ii.	1.d.ii.	1.a.ii.	2.a. + 3.c.	1.b.vi.	1.b.ii.
Water Quality Criterion						
Water Quality (TSS Loadings pounds per year)	59,400	59,400	59,500	59,400	59,400	59,400
Water Quality Score	10	10	10	10	10	10
Other Criterion						
Functionality (Reliability)	7.6	6.3	5.2	5.0	6.2	5.4
Functionality (Land Required)	5.6	5.2	4.1	3.8	4.1	4.1
Environmental (Odor & Noise)	6.4	6.9	5.6	4.8	5.8	5.7
Environmental (Slopes & Shoreline)	6.4	6.4	6.0	5.6	5.8	3.7
Neighborhood Acceptability	6.1	6.1	5.5	4.8	4.9	5.1
Constructability	5.8	6.2	6.1	6.6	5.2	3.7
Average Non-monetary Score	6.8	6.7	6.1	5.8	6.0	5.4
Weighted Score	8.4	6.6	3.6	5.7	4.9	5.1

5.4 Results of Screening of Six Refined CSO Reduction Alternatives

An inspection of the weighted score yields the following:

- x **Alternative 1 - Eastside Advanced Wastewater Treatment Plant** received the highest overall score of 8.
- x **Alternative 2 - Reroute portion of I06 to I08 Storage** is the next highest with a score of 7.
- x The remaining alternatives had scores ranging from 3 to 6.

Alternative 1 depends upon the implementation of a new wet and dry weather treatment facility which provides shared benefits to regional partner agencies. The facility would require a location at or near the intersection of Interceptor Segments I05 & I07.

The recommended alternative from this analysis is discussed in the next chapter.

Chapter 6: Recommended System-wide CSO Reduction Alternative

In this chapter, the results of the screening and ranking evaluation completed in Chapter 5 are used to select the recommended system-wide CSO reduction alternative. This will be the basis for the City's CSO reduction Capital Improvement Program (CIP).

6.1 System-wide CSO Reduction Alternative Recommendation

Previously, two alternatives were recommended for achieving required CSO reduction:

- x **Alternative 1 - Eastside Advanced Wastewater Treatment Plant** This alternative was the highest scoring system-wide CSO reduction alternative as it pertains to wet weather needs. However, this alternative depends on the integration of wet weather management (CSO) with a proposed regional, secondary-level wastewater treatment plant (EWTP). The facility should be located near the intersection of interceptor segments I05 and I07. Other locations for the EWTP could significantly affect the total cost of this alternative and its comparison score. This regional concept through discussions between the City of Spokane, Spokane County and the City of Spokane Valley, was not confirmed as a definite plan.
- x **Alternative 2 - Reroute portion of I06 Wet Weather Flows to New I08 Storage.** This alternative was the second highest scoring system-wide CSO reduction alternative.

A second alternative was identified in order to address the uncertainty associated with Alternative 1. Alternative 1 depends on the implementation of a new wet weather/ dry weather wastewater treatment facility. In order to realize the cost advantage for this facility, it is required to be located at or near the intersection of Interceptor Segments I05 and I07. The feasibility of this treatment facility was reviewed by local officials from Spokane County, City of Spokane Valley and the City of Spokane. Deliberations included treatment facility locations, treatment capability and operational responsibilities.

Through these discussions, alternatives to the regional treatment plant were identified. These alternatives proposed a dry weather treatment facility operated by Spokane County which could accept a diversion of flows from Interceptor Segment I07 or CSO Basin 34. This generated the following variations of Alternative 2:

- **Alternative 2a □ Reroute of Portion of I06 Wet Weather Flows to New I08 Storage**
- **Alternative 2b □ Reroute of Portion of I06 Wet Weather Flows to New I08 Storage**, in conjunction with a constant (no diurnal variations) 2.5 mgd diversion of City flows to a new SCWTP.

The diversion's source would be flows originating from tributary areas of Interceptor Segment I07. The feasibility of Alternative 2b is dependent upon the future location of a Spokane County Wastewater Treatment Plant (SCWTP). Sites under consideration were the site of the old cattle stockyard (Stockyard Site) and the horse racetrack site (Playfair Site). Spokane County conducted a number of public workshops to review the feasibility of each site and determined that the preferred site was the Stockyard Site. This location increased the cost of the diversion conveyance system significantly. This increased cost has made the diversion impractical economically. Therefore, the preferred CSO system wide alternative selected was Alternative 2, variation 2a. A summary of CSO Reduction Facilities and costs is presented in **Table 6-1**.

Table 6-1 Estimated Costs for Preferred System-wide CSO Reduction Alternatives

Description	Alternative 2a Reroute of Portion of I06 Wet Weather Flows to New I08 Storage (\$million)
Old ID Number (See Table 3-2)	1.d.ii.
Wet Weather Construction	166
Wet Engineering, Administration, & Contingency	67
Wet Weather Property Cost	10
Wet Weather Construction Subtotal	243
Wet Weather O&M Present Value	20
Wet Weather Total Net Present Value (NPV)	263
Secondary Treatment Capital - SCWTP	0
Secondary Treatment Capital - RPWRF	51
Total Net Present Value (NPV)	314

6.2 Description of the Recommended CSO Alternative**6.2.1 The recommended alternative is Alternative 2a ☐ Reroute Portion of I06 Wet Weather Flows to New I08 Storage. This alternative consists of the following components:**

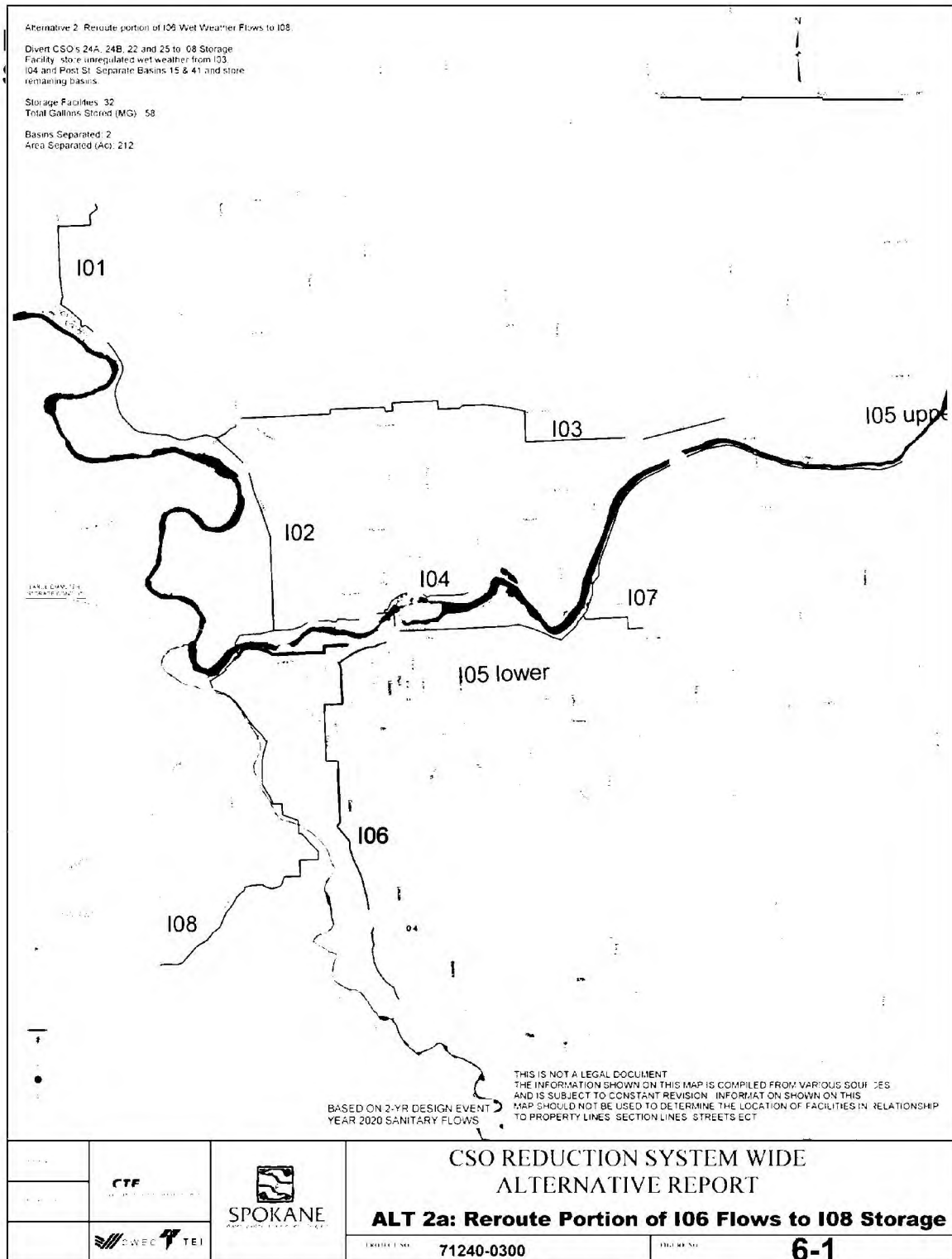
- x Conveyance and Integrated Storage. A portion of I06 flows are to be rerouted to an I08 related storage facility, which consists of a joint storage facility for CSO Basins 24a, 24b, and 25.
- x Unregulated I&I Reduction and Integrated Storage. The RDI&I and potential Snow Melt from I03 is considered to be managed through future I&I reduction efforts to 50% of the current level with subsequent storage of the remaining excess flow.
- x Separation. CSO Basins 15 and 41 will receive separate storm water sewers to divert wet weather flows from the sanitary sewers and their overflows will be eliminated. These new storm sewers will be fitted with primary treatment devices and then connected to the existing CSO outfall.
- x Storage at RPWRF. Because the current wet weather capacity of the RPWRF is set at 100 million gallons per day (mgd), a storage facility is proposed to equalize the peak flows that exceed 100 mgd entering RPWRF. This proposed RPWRF storage facility may be reduced in size if additional dry weather or wet weather treatment capacity is provided at RPWRF.
- x CSO Basin Storage. Storage facilities are planned for the remaining CSO basins. A joint storage facility, which means consolidating regulators and outfalls, will be used for CSO Basins 38, 39 and 40 and CSO Basins 16 and 18. On CSO basins such as CSO 34, the required storage will be strategically distributed throughout the basin for maximum benefit of conveyance and available space for facilities. With the exception of RPWRF, the storage facility sizes range from 130,000 gallons to 7 million gallons, with an average size of 1.5 million gallons.

The effects of this alternative on the existing system can be partially described by changes in the flows released to the interceptor. The existing weir settings and proposed storage outflow settings to downstream trunks and interceptors for each sub-alternative are described below. Because the unregulated wet weather areas such as I03 and I04 will be controlled under this recommended alternative, the interceptor inlet diversion rates for CSO regulators 6, 7, 12, 26, 34, 38, 39, and 40 were increased to minimize CSO storage sizes in those basins. The proposed storage facilities will have a diversion structure that controls flows released to the interceptor at a relatively constant maximum rate, even with increasing upstream flows and hydraulic head. This amounts to a more efficiently managed interceptor system, particularly for larger (> 2-year frequency) storm events, and is consistent with EPA's Nine Minimum Controls guidance for maximizing flows to the treatment plant. Alternative 2a is shown in **Figure 6-1**. The sizes and estimated costs for required CSO reduction facilities associated with this alternative are summarized in **Table 6-2** and given the following:

- X The estimated total capital cost (2003 dollars), including engineering and administration at 25%, a 15% contingency, property acquisition and O&M, is approximately \$314 million (net present value).
- X The estimated, total annual O&M cost for managing and treating contained CSO is approximately \$1.21 million (2003 dollars), which can be separated into \$0.76 million (2003 dollars) for O&M for additional CSO reduction facilities and \$0.45 million for treating contained CSO at RPWRF.

6.3 Recommended System-Wide CSO Alternative and CIP

The proposed facilities described above were incorporated into a capital improvement schedule to provide a relatively uniform annual cost (including other parallel CIP activities still satisfying the program goal of implementation by the year 2017. The CIP for the recommended alternative consists of estimated property acquisition, design, construction management, and construction costs per year, and are summarized in **Tables 6-3**. The projects were also sequenced to protect the interceptor from excess flow conditions during implementation of CSO projects. Preliminary design was roughly estimated at 3% of the capital cost, which the entire design was estimated as 10% of the capital cost. Smaller (less than \$1 million) or more complex (multiple regulator) facilities may warrant higher design to capital cost ratios. Application of wet weather flow control to the identified unregulated areas (I03, I04 and Post Street Bypass) is scheduled early in the program to provide interceptor capacity. Several CSO Basins and the unregulated areas require additional study to optimize storage sites to provide for both CSO control and address potential system surcharging. Therefore, these CSO Basin facilities are delayed until later in the sequence.



**Table 6-2 Summary of Sizes and Costs for Required CSO Reduction Facilities Alternative 2a □
Reroute Portion of I06 to I08 Storage (No City Flows to SCWTP)**

Location Description	2003 Regulator Onset of Overflow (threshold) (mgd)	CSO Control	Proposed Flow Control Setting (mgd)	2-year CSO Design Volume (gallon)	Const. Cost Subtotal (2003\$)	Property Cost (2003\$)	Engr, Admin, CM, Contingency (2003\$)	Capital Cost (2003\$)	Annual O&M (2003\$)
Interceptor Conveyance Upgrades	-	-	-	not applicable					
CSO Basin 06-1	1.81	Storage	6.07	2,479,000	\$7,076,000	\$414,000	\$2,830,000	\$10,321,000	\$23,000
CSO Basin 06-2									
CSO Basin 07	1.03	Storage	3.23	163,000	\$815,000	\$10,000	\$326,000	\$1,151,000	\$17,000
CSO Basin 10	0.39	Storage	0.39	217,000	\$1,037,000	\$14,000	\$415,000	\$1,465,000	\$17,000
CSO Basin 12-1	1.07	Storage	6.46	481,000	\$1,942,000	\$30,000	\$777,000	\$2,749,000	\$18,000
CSO Basin 12-2	no outfall	Storage	6.46	602,000	\$2,660,000	\$38,000	\$1,064,000	\$3,762,000	\$18,000
CSO Basin 14	0.90	Storage	0.90	222,000	\$1,056,000	\$28,000	\$422,000	\$1,506,000	\$17,000
CSO Basin 15	-	Separation	-	-	\$2,849,000	\$20,000	\$1,140,000	\$4,009,000	\$29,000
CSO Basin 16-18	2.91	Storage	2.75	316,000	\$1,595,000	\$20,000	\$638,000	\$2,252,000	\$18,000
CSO Basin 19	5.65	Weir Mod.	5.65	-	\$100,000	\$20,000	\$40,000	\$160,000	\$10,000
CSO Basin 20	6.52	Storage	9.69	250,000	\$1,160,000	\$94,000	\$464,000	\$1,717,000	\$18,000
CSO Basin 22b	2.91	Weir Mod.	CSO 25 controlled	-	\$100,000	\$20,000	\$40,000	\$160,000	\$10,000
CSO Basin 23-1	0.95	Storage	0.95	169,000	\$845,000	\$28,000	\$338,000	\$1,211,000	\$17,000
CSO Basin 23-2	no outfall	Storage	0.48	1,353,000	\$4,390,000	\$226,000	\$1,756,000	\$6,372,000	\$20,000
CSO Basin 24 a&b-1	no outfall	Storage	25.84	790,000	\$2,872,000	\$347,000	\$1,149,000	\$4,368,000	\$19,000
CSO Basin 24 a&b-2	9.85	Joint Storage	9.53	5,246,000	\$12,778,000	\$1,644,000	\$5,111,000	\$19,533,000	\$31,000
CSO Basin 25	0.60		0.54						
CSO Basin 26-1	18.15	Storage	32.30	6,684,000	\$17,882,000	\$1,117,000	\$7,153,000	\$26,151,000	\$34,000
CSO Basin 26-2	no outfall	Storage	6.46	391,000	\$2,611,000	\$418,000	\$1,044,000	\$4,073,000	\$18,000
CSO Basin 33a	0.94	Storage	0.94	138,000	\$690,000	\$32,000	\$276,000	\$998,000	\$17,000
CSO Basin 33b	10.00	Storage	9.88	3,863,000	\$10,039,000	\$887,700	\$4,015,000	\$14,942,000	\$27,000
CSO Basin 33c	1.03	Storage	1.03	221,000	\$1,052,000	\$51,000	\$421,000	\$1,524,000	\$17,000
CSO Basin 33d	0.71	Storage	0.58	773,000	\$2,823,000	\$177,000	\$1,129,000	\$4,130,000	\$19,000
CSO Basin 34-1	10.50	Storage	1.94	2,796,000	\$9,829,000	\$584,000	\$3,932,000	\$14,345,000	\$24,000
CSO Basin 34-2	no outfall	Storage	6.46	1,322,000	\$4,310,000	\$276,000	\$1,724,000	\$6,311,000	\$20,000
CSO Basin 34-3	no outfall	Storage	25.84	7,075,000	\$16,176,000	\$1,478,000	\$6,470,000	\$24,124,000	\$35,000
CSO Basin 34-4	no outfall	Storage	129.20	1,396,000	\$4,500,000	\$292,000	\$1,800,000	\$6,591,000	\$21,000
CSO Basin 34-5	no outfall	Storage	12.92	586,000	\$2,270,000	\$122,000	\$908,000	\$3,299,000	\$18,000
CSO Basin 34-6	no outfall	Storage	28.42	2,440,000	\$6,988,000	\$510,000	\$2,795,000	\$10,293,000	\$23,000
CSO Basin 38, 39, 40	.39, .45, .39	Storage	4.52	416,000	\$1,732,000	\$183,000	\$693,000	\$2,608,000	\$18,000
CSO Basin 41	-	Separation	-	-	\$2,380,000	\$20,000	\$952,000	\$3,352,000	\$27,000
CSO Basin 42	1.39	Storage	1.39	140,000	\$700,000	\$29,000	\$280,000	\$1,009,000	\$17,000
Interceptor 3-1	no outfall	Storage	6.46	279,000	\$1,264,000	\$29,000	\$506,000	\$1,799,000	\$18,000
Interceptor 3-2	no outfall	Storage	12.92	759,000	\$2,783,000	\$80,000	\$1,113,000	\$3,976,000	\$19,000
Interceptor 4-1	no outfall	Storage	5.49	3,375,000	\$9,025,000	\$353,000	\$3,610,000	\$12,987,000	\$26,000
Interceptor 4-2	no outfall	Storage	0.97	221,000	\$1,052,000	\$23,000	\$421,000	\$1,496,000	\$17,000
Post Street	no outfall	Storage	1.29	204,000	\$988,000	\$219,000	\$395,000	\$1,602,000	\$17,000
Eastside WTP	-	-	-	-					
RPWRF	no outfall	Storage	100.00	12,943,000	\$26,082,000	\$0	\$10,433,000	\$36,514,000	\$51,000
RPWRF Wet Treatment (O&M)	-	add'l flow	-						
TOTAL				58,310,000	166,451,000	9,834,000	66,580,000	242,860,000	1,212,000

Table 6-3 CIP for Alternative 2a

Description	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CSO Basin 16&18			0.18	2.07											
CSO Basin 19			0.03	0.13											
CSO Basin 22b				0.03	0.13										
CSO Basin 41				0.07	0.19	3.09									
CSO Basin 15					0.09	0.22	3.70								
CSO Basin 14					0.03	0.10	1.37								
CSO Basin 42			0.02	0.08	0.91										
CSO Basin 10			0.03	0.09	1.35										
Interceptor I03-1					0.04	0.12	1.64								
Interceptor I03-2						0.08	0.27	3.62							
CSO Basin 06-1						0.21	0.91	5.13	4.07						
CSO Basin 07								0.02	0.07	1.06					
CSO Basin 12-1							0.06	0.17	2.53						
CSO Basin 12-2									0.08	0.22	3.46				
CSO Basins 38, 39& 40									0.05	0.30	2.25				
Interceptor I04-1								0.27	0.98	6.54	5.19				
Interceptor I04-2								0.03	0.10	1.37					
Post Street								0.03	0.29	1.28					
CSO Basin 23-1						0.03	0.09	1.10							
CSO Basin 23-2							0.13	0.53	5.71						
CSO Basin 26-1										0.54	0.56	1.81	5.81	8.72	8.72
CSO Basin 26-2												0.08	0.60	3.39	
CSO Basin 24 a&b-1										0.09	0.55	3.73			
CSO Basin 24 a&b-2								0.38	0.55	0.55	0.55	0.89	4.15	6.23	6.23
CSO Basin 20									0.03	0.18	1.51				
CSO Basin 33a					0.02	0.08	0.90								
CSO Basin 33b						0.30	0.70	0.44	0.44	6.53	6.53				
CSO Basin 33c						0.03	0.07	0.05	1.37						
CSO Basin 33d						0.08	0.20	0.18	3.67						
CSO Basin 34-1										0.29	1.27	6.39	6.39		
CSO Basin 34-2									0.13	0.30	0.28	5.60			
CSO Basin 34-3									0.49	0.49	0.49	1.62	5.26	7.89	7.89
CSO Basin 34-4												0.13	0.31	0.29	5.85
CSO Basin 34-5											0.07	0.28	2.95		
CSO Basin 34-6											0.21	1.00	4.54	4.54	
SAWTP											0.78	1.83	8.48	12.71	12.71
Total (million \$)			0.26	2.47	2.75	4.35	10.05	11.96	20.55	19.74	23.69	23.38	38.50	43.78	41.40

Note: CSO Basin 06-1 includes the cost associated with 06-2. CSO Basin 25 costs are included in CSO Basin 24.

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Chapter 8: Appendix

Appendix A. Supporting Information to Alternative Analysis

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Appendix A: Supporting Information to Alternative Analysis

- Memo on Storage Cost Refinement
- Memo on Separation Cost Refinement CSO 15
- Memo on Separation Cost Refinement CSO 41
- Memo on Average Precipitation Year

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CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

MEMORANDUM

140 SOUTH ARTHUR STREET • SUITE 500 • SPOKANE, WA. 99202 • (509) 535-5454 • FAX (509) 535-5725

TO: CSO PMO **cc:** file

FROM: Duane Studer

DATE: September 24, 2003 **PROJECT#:** 71240-300

SUBJECT: Refined Basin Preferred Alternative Selection: Storage or Separation

This memorandum presents an update of basin-level CSO reduction costs for storage and separation, and a refinement of basin-preferred CSO reduction alternative selection. Both are based on refined unit costs for storage and separation. Any changes between the previous selection and the current refined selections of basin-preferred CSO reduction alternatives are noted and discussed.

BACKGROUND

Recently, unit cost factors for storage (*Refined CSO Storage Costs*, CTE Engineers, 2003) and separation (*Evaluation of Separation Analysis Methods and Refinement of Separation Costs for CSO Basin 15*, CSO PMO, 2003 and *Refinement of Separation Cost Estimates for CSO Basin 41*, CSO PMO, 2003) were refined. These unit cost factors changed enough that updates to both estimates of CSO reduction alternative costs and selection of the most cost effective basin-preferred alternatives were warranted.

In these analyses, storage is defined as detention of sewage adjacent to the sewer system in a tank or other storage facility to mitigate peak flow rates that may otherwise overflow from the combined sewer system. Separation is defined as construction of new storm drainage facilities so that sanitary sewage and storm drainage are conveyed in different sewers.

In all cases, all alternative analyses in terms of facility sizing are based on a design year of 2020, using a 2-year, 24-hour design storm with 8 mgd of base wastewater flow from the County and City of Spokane Valley in the eastern part of the overall sewer system service area being diverted to an additional wastewater treatment facility.

BASIS OF REFINED CONSTRUCTION COST ESTIMATES

The basis of the refined construction cost estimates for separation and storage are discussed below. All dollar figures are 2003 dollars unless otherwise specified.

Separation

During previous basin preferred cost estimating performed by the CSO PMO, a single, gross area separation unit cost factor of \$18,000 per acre (1999 dollars) was used, where this unit cost factor did not include allied costs such as engineering, construction management, or contingency. Adjusting this unit cost factor to 2003 dollars using Engineering News Record inflation indices and rounding to the nearest \$1,000 yields a unit cost factor of \$21,000 per acre.

The most recent unit cost refinement analyses conducted, and documented in the memorandum cited above, for CSO Basins 15 and 41 resulted in unit cost factors on the order of \$21,000 per acre. This unit cost factor does not include allied costs such as engineering, construction management, or contingency. With this refined unit cost factor substantiating the previous unit cost factor (applied to gross area) of \$21,000 per acre for residential (i.e., simpler separation), it was used to determine basin preferred alternative costs and will be used for all subsequent cost estimating. A more expensive unit cost factor for separation of \$41,000 subsequently was used for areas that have commercial development or where

removal of storm water from the combined system is anticipated to be highly difficult □such as that which exists in CSO Basins 25, 26, 33c&d, 34, and 42.

In all cases, the cost for storm water treatment using a vortex system capable of providing primary treatment was added under a separate line item based on a flow dependent cost curve from the manufacturer's information:

$$CDS \text{ Construction Cost, } \$ = [7.8564 * (\text{peak runoff flow, mgd}) + 117.97] * 1,000$$

This value was then adjusted to 2003 dollars by ENR index ratio of 6605/6059, or 1.09. This method of cost estimating for treatment was also conducted for previous cost estimating and will be used for all subsequent cost estimating for planning.

Storage

Refined storage construction costs are based on a volume dependent cost curve developed from historical costs:

$$\text{Unit storage cost, } \$/\text{gallon} = 3.4589 * (\text{storage volume, million gallons})^{-0.2116}$$

Unit storage cost is in terms of 2003 dollars. Storage sizes smaller than 175,000 gallons were assigned a cost cap of \$5/gallon. This estimate is further described in *Refined CSO Storage Costs* (CTE Engineers, 2003).

BASIS OF REFINED CAPITAL AND NET PRESENT VALUE COSTS

The basis of the refined capital cost estimates for separation and storage are discussed below. All dollar figures are 2003 dollars unless otherwise specified.

In all cases, the following apply:

- X Capital costs consist of construction costs plus 15% for contingency; design engineering (10% of construction cost), and construction management (15% of construction cost). Estimates of property costs were added where appropriate.
- X Annual operation and maintenance (O&M) costs were converted to present value cost using a 30 year term and an annual discount rate of 4%.
- X Capital costs were added to the present value of the O&M costs to provide a total alternative net present value cost.

Separation

Annual O&M costs were based on City historical trends needed for the O&M of separate storm sewers (\$65/acre/year, 2003\$). The annual O&M for the CDS treatment were based on monthly cleaning frequency (\$1,500 each).

Storage

Annual O&M costs for storage facilities were estimated according to the following equation developed in *Refined CSO Storage Costs* (CTE Engineers, 2003):

$$\text{Annual O\&M Cost, } \$ = 2,600 * (\text{storage volume, million gallons}) + 16,900$$

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These values were calculated in terms of 2003 dollars.

RESULTS OF REFINED COST ESTIMATES

Table 1 lists the refined storage and separation net present value costs for each basin, and presents the previously selected basin preferred alternatives. Under the current analysis using refined cost estimates, the lowest net present value cost alternatives for CSO Basins 25 (net present value cost of storage is \$2.4 million and separation is \$2.0 million) and 33d (net present value cost of storage is \$4.1 million and separation is \$4.0 million) have changed from the previous cost estimating, where separation is now more cost-effective than storage in both of these cases.

In addition, the differences between net present value costs for separation and storage for CSO Basins 6 (net present value cost of storage is \$17.1 million and separation is \$18.3 million), 26 (net present value cost of storage is \$41.0 million and separation is \$42.6 million), and 38 (net present value cost of storage is \$2.9 million and separation is \$3.0 million) have narrowed sufficiently that the selection of a basin preferred alternative for these CSO basins warrants additional scrutiny in each case.

CSO Basin 6

For CSO Basin 6, storage within the basin is shown to be most cost effective; however, a total storage volume of about 2.5 million gallons is required for this basin. Preliminary siting analysis being conducted by the CSO PMO has not clearly identified available space for this total volume.

Therefore, it may be prudent to include some separation in conjunction with storage because storage may become more costly as additional property purchases are needed.

CSO Basin 25

CSO Basin 25 lies on the west edge of the central business district with large commercial, historic, and multi-family buildings. Separation would likely involve separation of roof drains within historic structures. Such construction proves very difficult with uncertainty of success of rerouting storm drainage. In addition, the potential savings that are shown under refined cost estimating may only amount to \$0.4 million, which may not warrant changing the previously selected basin preferred alternative. Finally, system-wide analyses have shown that joint storage for CSO Basins 24a and 25 is feasible and cost-effective. For such a joint storage facility, the total cost for storage for CSO Basins 24a and 25 would be about \$20 million and total separation for CSO Basins 24a and 25 would be \$61.8 million.

Thus, storage will continue to be the basin preferred alternative for CSO Basin 25.

CSO Basin 26

CSO Basin 26, as part of the central business district, is primarily commercial with multi-story buildings and concentrated utilities. Separation would most likely involve extensive construction. In addition, storage remains more cost effective than separation.

Thus, storage will continue to be the basin preferred alternative for CSO Basin 26.

CSO Basin 33d

CSO Basin 33d is almost entirely commercial with a main trunk located within a major arterial street (Sprague Ave.). In addition, significant lengths of sewer in CSO Basin 33d are quite deep (up to 30 ft). The current savings that are shown under refined cost estimating, where "difficult" separation unit cost factors were used, amount to \$0.1 million, which is not a value of significance to warrant changing the previously selected basin preferred alternative.

Thus, storage will continue to be the basin preferred alternative for CSO Basin 33d.

CSO Basin 38

CSO Basin 38 is a good candidate for separation because it is comprised primarily of residential land use located over a well-drained soil type. It has been observed that in Spokane roof leader connections have typically not been used in residential areas.

System-wide analyses have shown that joint storage for CSO Basins 38, 39, and 40 is feasible and cost-effective. For a joint storage facility, two alternatives have been considered:

- x If all three CSO basins were analyzed as a single system, the total cost for joint storage for these three CSO basins would be \$4.4 million and total separation for these three CSO basins would be \$7.8 million.
- x If CSO Basin 38 was separated and storage was selected for the remaining two CSO basins, then the total cost for joint storage for CSO Basins 39 and 40 would be \$2.3 million and separation for CSO Basin 38 would be \$3.0 million, yielding a total combined cost of \$5.3 million. This combination of CSO reduction alternatives for CSO 38, 39, and 40 is \$0.9 million more expensive than the \$4.4 million joint storage facility.

This analysis shows that a joint storage facility is clearly more cost-effective; thus, storage, in the form of a joint storage facility, will continue to be the basin preferred alternative for CSO Basin 38 (in conjunction with CSO Basins 39 and 40).

CONCLUSION

Based on the refined cost estimating reported in this memorandum, the following conclusions apply:

1. The only CSO basin whose previous basin preferred alternative selection may be altered due to the refined cost estimating that has been described herein is CSO Basin 6. The decision to provide separation in conjunction with storage may be further clarified by model extension into the basin to study possible sewer system flooding issues.

This mixed approach to areas with limited sites for CSO storage may be typical of other CSO basins where separation costs are comparable to storage costs during the facility design process.

2. All other previous basin preferred alternative selections still apply, including storage for CSO Basins 25, 26, 33d, and 38. For Basin 38, *joint* storage in conjunction with CSO Basins 39 and 40 has been identified as the most cost effective.

Table 1. Summary of Refined Cost Estimates for Basin Level Storage and Separation

CSO Basin (I.D. No.)	Runoff Area (acres)	2-year CSO Design Volume with snowmelt (million gallon)	Previously Selected Basin Preferred Alternative	Refined Basin Level Cost Estimate ⁽¹⁾ (Net Present Value, 2003 \$)	
				Storage (\$million)	Separation (\$million)
6	511	4.488	Storage	\$17.1	\$18.3
7	121	0.297	Storage	\$2.2	\$4.6
10	55	0.229	Storage	\$1.8	\$2.5
12	358	2.610	Storage	\$10.9	\$12.6
14	71	0.221	Storage	\$1.8	\$2.9
15	123	1.050	Separation	\$5.5	\$4.5
16A,B&18	158	0.243	Storage	\$2.2	\$5.7
20	254	0.304	Storage	\$2.3	\$9.2
23	164	1.305	Storage	\$6.5	\$10.9
24A	1,865	5.036	Storage	\$20.0	\$59.8
24B	71	0.116	Storage	\$1.1	\$2.9
25	21	0.280	Storage	\$2.4	\$2.0
26	617	12.193	Storage	\$41.0	\$42.6
33A	67	0.139	Storage	\$1.3	\$3.0
33B	1,099	3.972	Storage	\$15.7	\$38.3
33C	16	0.220	Storage	\$1.8	\$2.0
33D	49	0.690	Storage	\$4.1	\$4.0
34	2,349	30.824	Storage	\$83.2	\$145.1
38	71	0.418	Storage	\$2.9	\$3.0
39	51	0.125	Storage	\$1.2	\$2.3
40	57	0.176	Storage	\$1.6	\$2.5
41	89	0.845	Separation	\$4.7	\$3.8
42	29	0.192	Storage	\$1.7	\$2.5

Notes:

(1) [REDACTED] data are for CSO basins whose more cost-effective basin level cost estimates have changed when calculated using the refined unit cost factors.

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ENGINEERS

MEMORANDUM

CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

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TO: CSO PMO **cc:** file

FROM: Duane Studer

DATE: September 23, 2003 **PROJECT#:** 71240-300

SUBJECT: Refined CSO Storage Cost

This memorandum presents refined unit costs factors for CSO storage for both construction and operation and maintenance (O&M) costs.

Background

Previous construction cost estimating for CSO storage utilized a relatively gross unit cost factor with a single step function to account for an "economy of scale" for size. Review of the EPA Manual for CSO storage has shown that the previous CSO PMO unit cost factors may underestimate storage costs.

In addition, previous O&M cost estimating for stored CSO utilized a cost factor that was based solely on annual volume of contained overflow. This approach did not take into account the relative size of a storage facility.

In this memorandum, these impacts on cost estimating CSO storage are evaluated and a refined set of unit cost factors are developed.

Construction Costs

Construction costs are intended to account for all labor, materials, and equipment required to construct a storage facility, but do not include property acquisition costs.

Previous Construction Unit Cost Factors. The unit cost factors for construction previously used by the CSO PMO were intended to account for "economy of scale" by means of a step function. Storage sizes smaller than 2 million gallons were assigned a construction unit cost of \$3.50/gallon. Storage sizes larger than 2 million gallons were assigned a construction unit cost of \$1.75/gallon. This step function is shown in Figure 1.

Current Construction Unit Cost Factors. In order to update the unit costs for storage, recent, actual project costs for constructed CSO storage projects from across the United States were evaluated by comparing their unit costs versus respective storage volumes. The particular CSO storage projects included in this analysis are listed in Table 1. These projects were selected for this analysis from a larger list of recently constructed CSO project because they uniformly included the following:

- X Odor control
- X Some rock excavation
- X Some dewatering
- X Various appurtenances such as self-flushing systems
- X Diversion structures
- X Hydrobrakes or vortex control valving

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- X Connecting conveyance piping
- X Pump Stations (most but not all)

The reported costs did not include property or land acquisition costs, and projects with substantial amenities were not utilized in this analysis.

In this table and subsequent cost curve developed from this data, the actual, reported costs for each selected, and listed, project were adjusted as follows:

- X To construction costs using a factor of 25% to account for engineering, construction management, and administration costs
- X To 2003 dollars using the ENR construction cost index
- X To the Spokane area using RS Means Construction Cost Data (2002) city index

This data was plotted in Figure 1, where the diamonds are the thrice adjusted actual unit costs values for each project and the solid line is the best-fit power curve for these data points. The equation of the power curve regressed from this data is:

$$\text{Storage Unit Cost} = .3 \times [\text{Design Volume (million gallons)}]^{.9116}$$

The correlation coefficient (R^2) for this curve was 0.4, which is considered to be within the accuracy of this level of cost estimating.

In developing this curve, no distinction in the actual configuration of the constructed storage (in-line or off-line, tank or tunnel) was made.

As a means of comparison, the CSO storage cost power curve referenced by the EPA is included in Figure 1 represented by the dashed line. This line is considerably greater than the best-fit curve determined in this analysis from the actual data and reflects the typical conservative stance taken by the EPA. As shown in Figure 1, this curve lies on the high side of the current data.

The impact of this refined basis for CSO storage construction cost estimating was evaluated by applying the refined basis to system-wide CSO Alternative 1. The result of this application is shown in Table 2. Using the refined basis, the total alternative construction cost increased by about \$16 million.

O&M Costs

The basic components of O&M for CSO storage are:

- X Inspection and partial cleaning of self-cleaning systems
- X Repair and flush water use costs for self-cleaning systems
- X Operation (electricity) and Maintenance (seals, instrumentation) for pumps
- X Odor control system upkeep and carbon replacement

The volume of a particular CSO facility may impact these components by the level of time and effort or magnitude of system needed to provide O&M, e.g. number of personnel required for a specified period of time to complete cleaning or inspection.

Previous O&M Cost Basis. The previous O&M cost basis utilized by the CSO PMO only used annual volume of overflow multiplied by a unit cost factor of \$0.01/gallon. However, this approach didn't consider the relative sizes of the storage facilities, nor the future predicted annual volume, which varies by alternative.

Current O&M Cost Estimates. The previous basis of estimating CSO O&M costs is refined herein where the specific components of O&M are assigned unit cost factors.

Inspection

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Bi-annual inspection is estimated at \$2,000/year, based on 2-man crew (city records) and 1 day per site visit.

No size adjustment is provided.

Self Cleaning

Storages can vary from rectangular cast-in-place concrete structures to a series of parallel box culvert sections or pipes. In all cases the CSO PMO is including self flushing systems consisting of either tipping buckets or flushing wave compartments (such as Hydro-Self from GNA). From a study of detention tank flushing (Parente et al, 1995), the estimated operation and maintenance cost for such a system is approximately \$250/event for a 2.8 million gallon tank. Using an average of 24 self-flushings/year would yield an annual cost of \$6000/year. The resulting unit cost, adjusted to 2003 dollars (ENR) is \$2,600 / million gallons / year.

Pump O&M

From wastewater pump station records for the City of Spokane, average annual O&M costs are approximately \$18,000 / year for each of the city's 26 stations. Operational (electricity) costs were estimated to be about one-third of the O&M total. In contrast to wastewater pump stations that operate year round, CSO pump stations may only operate one month out of the year. Therefore, O&M for CSO pump stations was estimated to cost about \$12,500/year.

No size adjustment is provided.

Odor Control

The typical odor control for CSO storage is considered to be carbon adsorption systems. From manufacturer information in 1999, the average annual cost for maintaining carbon filters was about \$2,200/year (average facility 0.5 to 1.0 million gallon), or \$2,400/year (2003 dollars).

No size adjustment is included.

Annual costs are summarized in Table 3.

Based on the values assigned to each of these O&M components, an annual O&M cost relationship was developed:

$$\text{Annual O \& M Cost} = \$6,900 + \$2,600 \times \text{Design Volume (million gallons)} @$$

The impact of this refined basis for O&M cost estimating was evaluated by applying the refined basis to system-wide CSO Alternative 1. The result of this application is shown in Table 4. Using the refined O&M cost estimate basis resulted in slightly lower total annual cost (\$1.31 million) than determined previously (\$1.77 million). However, the distribution of O&M costs across the basins was more uniform.

Conclusion

Based on the application of the two refined bases for estimating costs of construction and O&M for CSO storage, the following can be concluded:

1. The construction cost curve is the mid-range of historical CSO storage construction costs, but is representative of expected costs in Spokane, Washington. Application of the new cost basis yielded an increase in estimated costs for the program of \$16 million for System-wide Alternative 1.

2. The use of this refined O&M cost basis yielded a decrease of \$0.46 million/year, for a total net present value of approximately \$8 million.

These two bases of cost estimating will be utilized through the remainder of the CSO facility planning process for Spokane, Washington.

References

Parente, M., Stevens, K. and C. Eicher. 1995. *Evaluation of New technology in the Flushing of Detention Facilities*. WEFTEC 68th Annual Conference.

Figures:

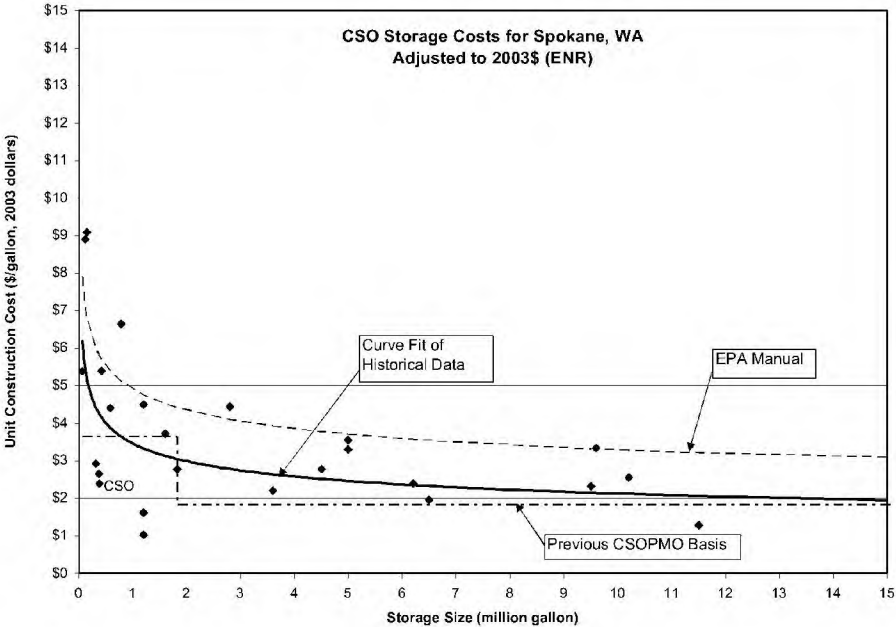


Figure 1. Development of Storage Unit Construction Cost Curve

Tables:

Table 1. List of Recent CSO Storage Projects and Costs

Source / Location	City Cost Index	Cost Basis Year	Storage Facility Description	Size (million gallon)	Type (pipe or tank)	Construction Cost (million\$) Adjusted to 2003 \$	Unit Cost (\$), Adjusted to 2003 \$	EPA curve (\$/gallon) 2003\$	2001 Storage Cost (2003\$)
Seattle, WA	105	2001	No.44, 72" & 84" pipes, HB/W	0.064	offline pipe	\$0.347	\$5.39	\$7.91	\$3.64
Seattle, WA	105	2001	No.40/42/43, 54" & 144" pipes, 3 HB/W	0.118	both, pipe	\$1.048	\$8.90	\$7.12	\$3.64
Seattle, WA	105	2001	No.137/138, 132" pipes, 2 HB/W	0.151	offline pipe	\$1.369	\$9.09	\$6.82	\$3.64
Seattle, WA	105	2001	No.49, 72" & 84" pipes, HB/W	0.316	offline pipe	\$0.924	\$2.92	\$5.99	\$3.64
Spokane, WA	98	2002	72" & 54" pipes w/pumps, non-flushed	0.367	offline pipe	\$0.972	\$2.65	\$5.84	\$3.64
Seattle, WA	105	2001	No.47, 24", 60", 72" & 78" pipes, 2 HB/W	0.380	Inline pipe	\$0.906	\$2.38	\$5.80	\$3.64
Seattle, WA	105	2001	No.68, 48", 72" & 144" pipes, 2 HB/W	0.418	both, pipe	\$2.252	\$5.39	\$5.71	\$3.64
W.Lafayette, IN	102	2002	Rectangular basin	0.583	unknown	\$2.572	\$4.41	\$5.39	\$3.64
Seattle, WA	105	2001	No.13/14/15, 72" & 96" pipes, 6 HB/W	0.782	both, pipe	\$5.198	\$6.65	\$5.12	\$3.64
Saginaw, MI	98	1994	Fitzhugh RTB, vortex-out	1.200	offline tank	\$5.390	\$4.49	\$4.75	\$3.64
Bangor, ME	93	1998	Davis-Brook tank	1.200	inline tank	\$1.224	\$1.02	\$4.75	\$3.64
Bangor, ME	93	2001	Kenduskeag East, box culverts, SCADA	1.200	offline box	\$1.939	\$1.62	\$4.75	\$3.64
Seattle, WA	105	2001	No.168, Detention Tank, HB/W	1.600	offline tank	\$5.947	\$3.72	\$4.52	\$3.64
Seattle, WA	105	2001	No.169, Detention Tank, HB/W	1.600	offline tank	\$5.947	\$3.72	\$4.52	\$3.64
Seattle, WA	105	2001	No.18, 72" & 144" pipes, 2 HB/W	1.826	2 In-line pipe	\$5.052	\$2.77	\$4.42	\$3.64
				1.826				\$4.42	\$1.82
Saginaw, MI	98	1994	Salt/Fraser RTB, meter-out	2.800	offline tank	\$12.447	\$4.45	\$4.10	\$1.82
Saginaw, MI	98	1994	Webber RTB, vortex-out	3.600	offline tank	\$7.939	\$2.21	\$3.92	\$1.82
Oak. Cnty, MI	107	1994	Acacia, sedimentation, DIS	4.500	offline tank	\$12.497	\$2.78	\$3.78	\$1.82
Saginaw, MI	98	1994	Emerson RTB, meter-out	5.000	offline tank	\$17.740	\$3.55	\$3.71	\$1.82
Nashville, Tn	86	1997	Driftwood Basin, 3 diversions	5.000	offline tank	\$16.517	\$3.30	\$3.71	\$1.82
San Fran., CA	124	1994	Sunnydale box culvert, W	6.200	unknown	\$14.848	\$2.39	\$3.57	\$1.82
Saginaw, MI	98	1994	14th St Basin, vortex separator, HB	6.500	offline tank	\$12.741	\$1.96	\$3.54	\$1.82
Saginaw, MI	98	1994	Weiss St. Basin, vortex separator	9.500	offline tank	\$21.954	\$2.31	\$3.32	\$1.82
Oak. Cnty, MI	107	1994	Birmingham, sedimentation, DIS	9.600	unknown	\$32.008	\$3.33	\$3.31	\$1.82
Oak. Cnty, MI	107	1994	Bloomfield Village, sedimentation, DIS	10.200	unknown	\$25.984	\$2.55	\$3.27	\$1.82
San Fran., CA	124	1994	Yosemite box culvert, W	11.500	unknown	\$14.748	\$1.28	\$3.21	\$1.82
Detroit, MI	107	2000	Hubbel-Southfield basin, DIS	22.000	offline tank	\$39.080	\$1.78	\$2.86	\$1.82
San Fran., CA	124	1994	North Shore box culvert, W	24.000	unknown	\$53.173	\$2.22	\$2.82	\$1.82
Grd Rapids, MI	85	1994	3 compartment tank, DIS	30.500	offline tank	\$33.716	\$1.11	\$2.71	\$1.82



Table 1 Notes:

Abbreviations:

RTB=retention treatment basin, HB=hydrobrake, W=weir, Box=box culvert, DIS=disinfection capable

Assumed markup for engineering, construction management and admin is 25% reduction on reported capital costs.



Table 2. Impact of Refined CSO Storage Construction Unit Cost Basis on Alternative 1.

2-year CSO Design Volume (gallon)	Previous Basis Construction Cost Subtotal (\$)	Refined Basis Construction Cost Subtotal (\$)
459,000	\$1,751,268	\$1,872,023
2,534,000	\$4,834,110	\$7,199,447
25,000	\$95,385	\$125,000
495,100	\$1,889,004	\$1,987,165
17,500	\$66,769	\$87,500
851,200	\$3,247,667	\$3,046,316
223,500	\$852,742	\$1,061,472
367,500	\$1,402,159	\$1,571,039
78,700	\$300,272	\$393,500
1,226,000	\$4,677,679	\$4,061,663
467,000	\$1,781,791	\$1,897,699
1,622,100	\$6,188,958	\$5,064,811
6,542,000	\$15,856,169	\$18,583,023
394,000	\$1,503,267	\$1,659,691
3,374,000	\$6,436,577	\$9,022,514
775,000	\$2,956,934	\$2,829,199
238,300	\$909,209	\$1,116,510
1,359,632	\$5,187,538	\$4,406,841
4,889,728	\$9,328,131	\$12,088,435
1,276,400	\$4,869,975	\$4,192,741
503,493	\$1,921,026	\$2,013,676
2,889,397	\$5,512,101	\$7,984,329
140,900	\$537,590	\$704,500
2,614,000	\$4,986,726	\$7,378,052
6,812,600	\$12,996,392	\$15,700,804
Total	100,089,000	116,048,000



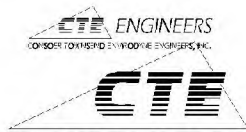
Table 3. Summary of CSO Storage O&M Costs

Description	Unit cost	Unit
Inspection & cleaning	2,000	\$ / year
Self-flushing O&M	2,600	\$ / million gallon / year
CSO Pump O&M	12,500	\$ / year
Odor Control O&M	2,400	\$ / year



Table 4. Impact of Refined O&M Cost on Alternative 1

Annual O&M (2003\$)	Annual O&M (2001 method 0.01/gallon Annual CSO)	Annual O&M (1% of Capital method)
\$21,250	\$144,310	\$75,720
\$17,943	\$34,590	\$35,020
\$17,126	\$3,320	\$6,230
\$19,134	\$74,122	\$43,860
\$18,172	\$0	\$28,070
\$17,305	\$4,350	\$10,990
\$22,727	\$93,912	\$96,350
\$16,925	\$398	\$680
\$17,476	\$750	\$15,040
\$17,876	\$210	\$22,600
\$16,945	\$10	\$1,230
\$16,984	\$620	\$2,310
\$20,147	\$24,030	\$59,790
\$17,781	\$4,320	\$21,700
\$21,335	\$45,198	\$75,550
\$17,464	\$5,748	\$14,740
\$17,127	\$2,313	\$6,850
\$30,495	\$333,633	\$234,120
\$17,677	\$19,077	\$21,860
\$29,427	\$67,530	\$188,400
\$18,920	\$10,890	\$43,090
\$17,544	\$0	\$17,050
\$17,340	\$400	\$12,240
\$23,676	\$69,059	\$109,030
\$18,600	\$18,400	\$37,380
\$17,355	\$940	\$12,660
\$33,431	\$265,243	\$221,440
\$18,281	\$22,152	\$30,510
\$34,947	\$289,565	\$237,570
\$20,255	\$53,829	\$61,900
\$20,301	\$54,567	\$62,570
\$24,170	\$116,644	\$114,760
\$18,008	\$8,970	\$26,580
\$17,263	\$120	\$10,080
\$47,741	\$0	\$365,700
\$512,170		
\$28,972		
\$26,784		
\$0		
\$0		
\$0		
\$0		
\$1,307,072	\$1,769,221	\$2,323,670



CONSOER TOWNSEND ENVIRODYNE ENGINEERS, INC.

140 SOUTH ARTHUR STREET • SUITE 500 • SPOKANE, WA. 99202 • (509) 535-5454 • FAX (509) 535-5725

MEMORANDUM

TO: CSO PMO **cc:** REM,GGS

FROM: Layne Merritt

DATE: September 5, 2003 **PROJECT#:** 71240-300

SUBJECT: Evaluation of Separation Analysis Methods and Refinement of Stormwater Separation Cost Estimates for CSO Basin 15

This memorandum presents a refinement of stormwater separation costs. Previous cost estimates were based on a unit cost factor of \$21,057 per acre (2003 dollars) applied to gross area. This factor does not include primary treatment, engineering, administration, construction management, or contingency costs. For this effort, two storm drainage facility design methods were performed by the CSO PMO. This memorandum presents a comparison of the results of these two methods. The methods used are as follows:

- X SCS TR-55 Method (as prescribed by the City in their stormwater regulations)
- X XP-SWMM Method (simpler approach that utilizes the efficiency of modeling using the current calibrated model and parameters specific to a basin)

A comparison of the costs from the two methods indicates that they are nearly equal. Therefore, either design method can be used for storm sewer design and associated cost estimating within the CSO program.

This memorandum addresses the design and associated costs as applied to CSO Basin 15, specifically. A companion memorandum has been prepared for CSO Basin 41. These two basins were identified for refinement of costs for stormwater separation because separation had been shown to be the most cost-effective for these two basins. Another companion memorandum, Refined Basin Preferred Alternative Selection: Storage or Separation, presents the results of updated cost estimating, at the basin level, for separation and storage to confirm basin level preferred alternatives.

BACKGROUND

All previous cost estimates for stormwater separation were based on a unit factor (\$21,057 per acre). Recent CSO PMO alternative cost estimate activities (where the basis for storage cost estimates have been refined as presented in the Technical Memorandum | Refined CSO Storage Costs |) have revealed that certain CSO basins that previously have been shown to have lower costs for storage to reduce CSO may have equal or lower costs for separation. This revelation has prompted this analysis to ensure that the most cost-effective approaches to reducing CSO and achieving the Ecology regulation for CSO reduction are presented.

CSO BASIN 15 DESCRIPTION

CSO Basin 15 is located in West Central Spokane, North of the Spokane River. It encompasses approximately 140 sanitary acres and 123 runoff acres. The regulator for CSO Basin 15 is located at the

Combined Sewer Overflow Reduction System Wide Alternative Report
A-21

12/23/2005



intersection of Nettleton Street and Ohio Avenue. The current CSO threshold for CSO Basin 15 is estimated to be 1.80 cfs (1.16 mgd).

SEPARATION ANALYZED USING THE SCS TR-55 METHOD

The SCS TR-55 Method is a typical industry method used for calculating the runoff from urban areas. In addition, the use of this method is specified by the City of Spokane in their stormwater regulations for calculating runoff. Specifically, the City of Spokane regulation states that the SCS TR-55 Method will be utilized, City of Spokane Design Standard 6.2-2, Runoff Calculations □ Drainage Areas Over 10 Acres: □ Runoff from areas larger than 10 acres should be analyzed using the Tabular Hydrograph method or Graphical Peak Discharge method presented in the U.S. Soil Conservation Service's Technical Release 55 (SCS TR-55), Urban Hydrology for Small Watersheds. □

Basis of Design: The previously defined CSO Basin 15 runoff area was subdivided using GIS mapping into sub-runoff areas tributary to new storm sewer alignments, as shown in Figure 1. This analysis is based on the assumption that the only storm flows entering the existing combined sewer system are from catch basins. Thus, any roof leaders, parking lots etc. that are currently connected to the combined system would not be separated.

Pipes were designed to a depth to diameter flow ratio of 1.0 or less. Pipe depths for north/south collector pipes were designed with a 6-foot cover, in accordance with City of Spokane Standard Plan W-109A, as shown in Figure 2. A 3-foot minimum cover is required, but a 6-foot depth to top of pipe is assumed due to the potential conflicts with other utilities such as water lines at depths shallower than 6 feet.

The combination of peak flows from each sub-basin was computed by the prescribed Tabular Hydrograph Method. Time flow delays were included in the analysis.

A key parameter for calculation of runoff using the SCS TR-55 Method is the Curve Number. The curve number is selected based on Table 2-2a in the TR-55 documentation, Urban Hydrology for Small Watersheds, USDA, NRCS, Technical Release 55. This table is presented as Figure 3. Based on an evaluation of lot sizes in CSO Basin 15, including street areas, the typical lot size is 1/6-acre. The percent impervious in CSO Basin 15, derived from GIS, is 48%, and correlates adequately with the interpolated value of 51% for percent impervious assumed in Table 2-2a of the TR-55 documentation. The prevalent soil type in CSO Basin 15 is the Garrison gravelly loam, which is classified as Hydrologic Soil Group B. Based on interpolation from the values in the Table 2-2a of TR-55, the selected curve number is 80 for CSO Basin 15.

The time of concentration selected for these basins is 0.1 hours. This is considered a reasonable value for small basins with paved and channeled runoff travel paths, and confirmed by an evaluation of the typical flow path in these subbasins.

The design storm selected is the 10-year, 24-hour Type II SCS storm with a total volume of 1.99 inches. The beta factor used to adjust rainfall for the design of CSO control facilities was not applied to this design event.

The runoff for each subbasin was calculated using the new Windows version of the TR-55 software, available from the USDA NRCS website. Runoff hydrographs were routed using the Tabular Hydrograph Method provided in the software.

Basis of Cost: The construction costs were generated from the Basis of Cost Report, (March 2002 □ CTE Engineers). The CDS swirl concentrator's cost was based upon a design peak flow (60.3 mgd) from the 10-year 24-hour storm. Other costs (manholes, asphalt, crushed top course, etc.) were generally estimated using the recent bid tabulations for CSO Basins 2 and 3c.

In order to transport the flows from the separate storm system for CSO Basin 15 to the river, it is necessary to either relieve, via a parallel line, or replace the existing outfall. In this analysis, a parallel relief line was assumed, with a cost estimate based on the same CSO PMO unit cost factors as identified above.

All costs are 2003 dollars throughout this memorandum.



Cost Estimate Summary. The total cost for separation as determined using the results from the SCS Method is \$4,300,000 (including primary treatment, contingency, engineering, and construction management costs). A detailed summary of the costs for separation of CSO Basin 15 by the SCS Method is shown in Table 1.

The cost for the outfall segment is estimated to be \$730,000 (including contingency, engineering, and construction management costs). This is included in the overall total cost of \$4,300,000. This upgrade to the outfall pipe represents a significant portion of the cost to achieve separation for CSO Basin 15. It is summarized separately in Table 2.

The cost for the stormwater primary treatment facility for this separate stormwater system is \$692,000 (without contingency, engineering, and construction management costs).

SEPARATION ANALYZED USING THE XP-SWMM METHOD

Model Development: To create load points for the model, the previously defined CSO Basin 15 runoff area was further subdivided using GIS mapping and the new storm sewer alignments as described previously and shown in Figure 1.

A separate model was then developed in XP-SWMM. The model utilizes the new runoff areas, load points as shown in Figure 4 along with the existing runoff parameters from the calibrated CSO model.

Similar to the SCS TR-55 Method, this model addressed catch basin inflow points only and utilized a similar pipe design and configuration approach.

The runoff data for the calibrated CSO basin XP-SWMM model are presented in Table 3. The current model has subdivided the existing basin into two runoff areas or load points, which is sufficient for system-wide combined sewer system analysis but not sufficient for local storm drain sizing. The runoff data for the subdivided basin model are listed in Table 4.

The hydrologic data for the CSO Basin 15 storm sewer model were based upon the CSO Basin 15 calibrated model. These are summarized as follows:

1. Infiltration □ shown in Figure 5.
2. Green-Ampt parameters □ shown in Figure 6. The value of 0.1 for initial moisture deficit is a conservative value assumed for saturated soil conditions. The calibrated value was 0.4 for initial moisture deficit.
3. Evaporation □ shown in Figure 7. The rainfall input file was generated using the spreadsheet *MDM Design Storm plus snow.xls*. The design storm is a 10-year, 24-hour event. The 0.5-year-frequency snow runoff was not included in this rainfall file, since it is not required in the current standards.

Basis of Cost: The pipe and treatment costs are based on the same cost factors as described previously for the SCS TR-55 Method. The peak flow from the XP-SWMM analysis is 57.1 mgd for the 10-year, 24-hour storm.

Similar to the SCS TR-55 Method, the existing outfall does not have sufficient capacity for the separate storm sewer flow rates; therefore, a parallel relief line was assumed, with a cost estimate based on the same CSO PMO unit cost factors as identified above.

Cost Estimate Summary: The total cost for stormwater separation from the XP-SWMM Method is \$4,300,000 (including primary treatment, contingency, engineering, and construction management costs). The estimate is nearly identical to the cost estimated from the SCS TR-55 Method. A summary of these costs are presented in Table 5.

The cost for the outfall is estimated to be \$720,000 (including contingency, engineering, and construction management costs), which is included in the overall total cost of \$4,300,000. This separate cost compares to an outfall upgrade cost of \$730,000 from the SCS TR-55 Method. The additional outfall pipe represents a significant portion of the cost to achieve separation for CSO Basin 15 and is summarized separately in Table 6.



The estimated cost for the stormwater treatment system for this stormwater separation system is \$663,000 (without contingency, engineering, and construction management costs).

COMPARISON OF SEPARATION COSTS: SCS TR-55 METHOD VERSUS XP-SWMM METHOD

Table 7 summarizes the estimated costs determined by each design method for separate storm sewers and outfall for CSO Basin 15. Generally, the total estimated costs are very similar. The resulting pipe design sizes may not be identical, but are similar. Table 8 lists the pipe diameters needed for the storm sewer system determined by each design method. Also listed in this table are invert elevations and pipe lengths. At this level of analysis, the two methods produce nearly the same results.

COMPARISON OF CSO MITIGATION COSTS: XP-SWMM METHOD FOR SEPARATION VS. STORAGE

The total estimated cost for separation of CSO Basin 15, using either design method is \$4,300,000. This cost does not include costs for separation of roof leaders, parking lots, and any other impervious surfaces on private property that might presently be connected to the combined sewer system. This yields a unit cost factor of \$34,960/acre (including primary treatment, contingency, engineering, and construction management costs).

By subtracting the cost of the stormwater treatment system from the total cost for separation and ignoring contingency, engineering, and construction management costs at the unit cost level, the unit cost factor ranges from \$19,400/acre (SCS method) to \$19,600/acre (XP-SWMM method). In comparison, the unit cost factor used previously was \$21,057/acre, which also excluded contingency, engineering, and construction management costs.

The estimated cost for the original, 2-year design storm (including snow melt) storage volume for CSO Basin 15 is \$5,032,000. The difference between the cost of separation and storage is approximately \$730,000 or 17% of the stormwater separation cost by the XP-SWMM method.

Stormwater separation remains a more economical alternative than storage for CSO Basin 15.

CONCLUSION

The analysis presented in this memorandum provides two conclusions:

1. Utilizing these refined stormwater separation costs results in a cost estimate approximately 8% lower than that which results from application of the previous unit cost factor. This result is both reasonable and not significant. Therefore, the unit cost factor of \$21,000/acre can continue to be used with confidence as a basis of estimating stormwater separation costs.
2. The two design methods (SCS TR-55 and XP-SWMM) produced nearly identical estimates of cost. Thus, the XP-SWMM model can be utilized for future analyses where a developed and calibrated model is available for use.



FIGURES:



Source: P:\GIS Projects\basin 15 separation 11m.apr

Figure 1. Storm Drain System Piping Layout and Basin Runoff Areas Subdivision

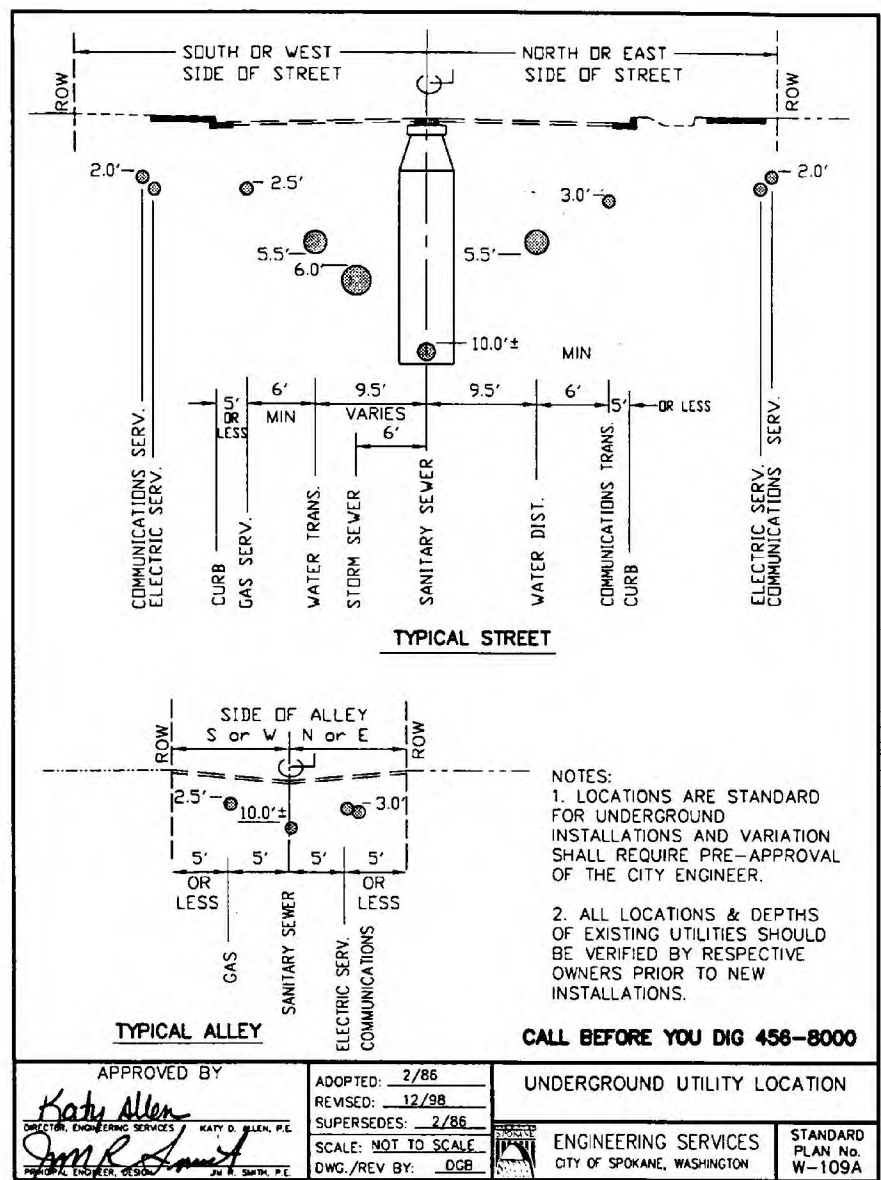
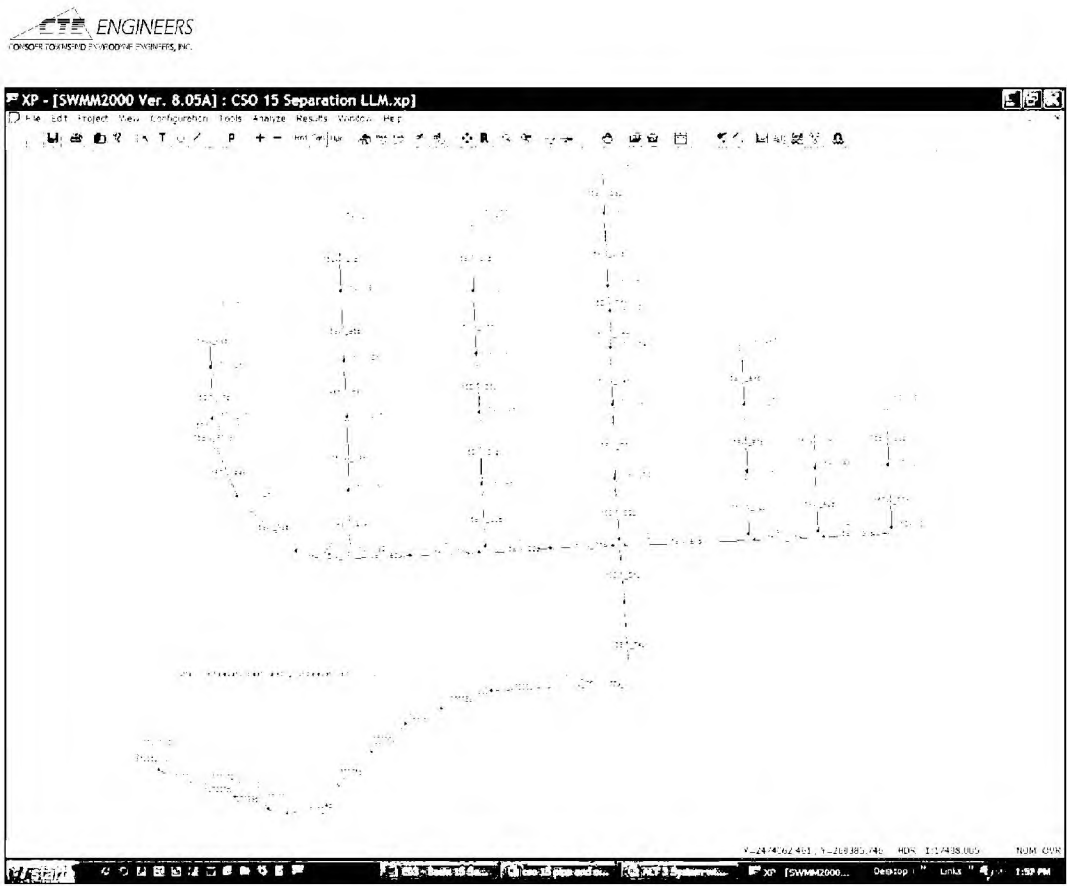


Figure 2. City of Spokane Storm Drain System Configuration Standard



Table 2-2a Runoff curve numbers for urban areas ¹					
Cover description		Curve numbers for			
		hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area ²	A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
Open space (lawns, parks, golf courses, cemeteries, etc.) ³ :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	60	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved, curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved, open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ⁴		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	48	64	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

Figure 3. Scan of Table 2-2a from TR-55 Manual




Source: X:\015\CSO 15 Separation LLM\CSO 15 Separation LLM Deep.xp

Figure 4. Storm Drain System Model Piping Layout



(R) Infiltration : CSO 15 Runoff



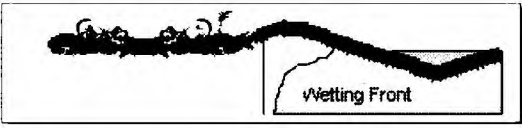
Equation
☐ Horton
☒ Green Ampt

	Impervious Area	Pervious Area
Depression storage () inch	<input type="text" value="0.1"/>	<input type="text" value="0.05"/>
Manning's n	<input type="text" value="0.014"/>	<input type="text" value="0.020"/>
Zero Detention (%)	<input type="text" value="0.0"/>	

Source: X:\015\CSO 15 Separation LLM\CSO 15 Separation LLM Deep.xp

Figure 5. Screen Capture of XP-SWMM Infiltration Parameters

(R) Green Ampt Equation : CSO 15 Runoff



Average Capillary Suction inch

Initial Moisture Deficit

Saturated Hydraulic Conductivity inch/hr

Source: X:\015\CSO 15 Separation LLM\CSO 15 Separation LLM Deep.xp

Figure 6. Screen Capture of XP-SWMM Antecedent (Green Ampt Method) Parameters



Evaporation

Direct Input

	Evaporation		Evaporation
Jan	.050	Jul	366
Feb	.050	Aug	336
Mar	.10	Sep	217
Apr	.164	Oct	100
May	.239	Nov	100
Jun	.289	Dec	.050

☒ Daily Values
 ☐ Monthly Values

☐ TEMP Interface File
 ☒ Use default of 0.1 inch/day

OK

Cancel

Source: X:\015\CSO 15 Separation LLM\CSO 15 Separation LLM Deep.xp

Figure 7. Screen Capture of XP-SWMM Evaporation Parameters



TABLES:



Opinion of Probable Cost

Description: **CSO Basin 15 Full Separation - SCS Tabular**

Table No. **1**

Project: City of Spokane CSO

By: **LLM**

CSO Basin 15

Date: **9/5/2003**

Location: Entire Basin 15 including outfall upgrades

Project No. **71240-300**

ITEM NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization	1	LS	\$ 75,000.00	\$ 75,000
2	12" Diameter PVC Sewer Pipe	1,600	LF	\$ 34.00	\$ 54,400
3	15" Diameter PVC Sewer Pipe	2,000	LF	\$ 40.00	\$ 80,000
4	18" Diameter PVC Sewer Pipe	2,250	LF	\$ 46.00	\$ 103,500
5	21" Diameter Concrete Sewer Pipe	2,600	LF	\$ 51.00	\$ 132,600
6	24" Diameter Concrete Sewer Pipe	1,600	LF	\$ 58.00	\$ 92,800
7	27" Diameter Concrete Sewer Pipe	1,130	LF	\$ 70.00	\$ 79,100
8	30" Diameter Concrete Sewer Pipe	350	LF	\$ 80.00	\$ 28,000
9	36" Diameter Concrete Sewer Pipe	700	LF	\$ 110.00	\$ 77,000
10	42" Diameter Concrete Sewer Pipe	700	LF	\$ 135.00	\$ 94,500
11	48" Diameter Concrete Sewer Pipe	550	LF	\$ 160.00	\$ 88,000
12	54" Diameter Concrete Sewer Pipe	1,750	LF	\$ 220.00	\$ 385,000
13	60" Diameter Concrete Sewer Pipe	50	LF	\$ 250.00	\$ 12,500
13	Manhole, Type I-48	27	EA	\$ 2,200.00	\$ 59,400
14	Manhole, Type I-54	3	EA	\$ 4,000.00	\$ 12,000
15	Manhole, Type III-54	13	EA	\$ 4,500.00	\$ 58,500
16	Manhole, Type II-72	1	EA	\$ 8,000.00	\$ 8,000
17	Manhole, Type II-96	3	EA	\$ 9,000.00	\$ 27,000
18	Manhole, Type III-72	3	EA	\$ 8,500.00	\$ 25,500
19	Manhole, Type III-96	5	EA	\$ 10,000.00	\$ 50,000
20	Connect Catch Basin Lines	80	EA	\$ 300.00	\$ 24,000
21	Asphalt Concrete Removal	49,700	SY	\$ 2.00	\$ 99,400
22	Asphalt Concrete Pavement, 3" Thick	49,700	SY	\$ 8.00	\$ 397,600
23	Sawing Flexible Pavement	2,400	LF	\$ 1.50	\$ 3,600
24	Crushed Surfacing Top Course	9,400	CY	\$ 30.00	\$ 282,000
25	Clearing and Grubbing	5,600	SY	\$ 2.00	\$ 11,200
26	Surface Restoration Unimproved Areas	6,800	SY	\$ 3.00	\$ 20,400
27	CDS Swirl Concentrator	1	LS	\$692,000	\$ 692,000
28	Construction Subtotal				\$ 3,073,000
29	Construction Contingency @ 15%				\$ 461,000
30	Engineering Design @ 10%				\$ 307,300
31	Construction Management @ 15%				\$ 461,000
	Project Total				\$ 4,300,000

Source: X:\015\CSO 15 Separation LLM\Basin 15 - Full Separation - SCS Method - Tabular - LLM.xls



Opinion of Probable Cost

Description: **CSO Basin 15 Outfall Only Costs - SCS Tab.**

Table No. **2**Project: City of Spokane CSOBy: LLM

CSO Basin 15

Date: 9/5/2003

Location: CSO Basin 15 Outfall Below Regulator

Project No. 71240-300

[illegible]

Source: X:\015\CSO 15 Separation LLM\Basin 15 - Full Separation - SCS Method - Tabular - LLM.xls



Table 3 Summary of Calibrated CSO Basin Runoff Data (2 load points)				
Loadpoint	Subbasin Runoff Area (acres)	% Impervious Subbasin	Width Subbasin	Slope
3702016	62	27	350	0.0044
3701221	61	25	350	0.0234
Total/Average	123	26	350	0.0139

Source: X:\015\CSO 15 Separation LLM\cso 15 separation subbasins llm.xls



Table 4
Summary of Calibrated, Subdivided CSO Basin Runoff Data (33 Subbasins)

Loadpoint	Subbasin Runoff Area (acres)	% Impervious Subbasin	Width Subbasin	Slope
15SW_G3	1.95	26	350	0.0234
15SW_G2	1.87	26	350	0.0234
15SW_G1	2.19	26	350	0.0234
15SW_F3	3.10	26	350	0.0234
15SW_F2	2.52	26	350	0.0234
15SW_F1	2.23	26	350	0.0234
15SW_E4	0.96	26	350	0.0044
15SW_E3	3.37	26	350	0.0234
15SW_E2	3.97	26	350	0.0234
15SW_E1	3.06	26	350	0.0234
15SW_D8	3.51	26	350	0.0044
15SW_D6	5.35	26	350	0.0044
15SW_D4	4.87	26	350	0.0044
15SW_D3	4.42	26	350	0.0234
15SW_D2	5.34	26	350	0.0234
15SW_D1	6.15	26	350	0.0234
15SW_C7	5.60	26	350	0.0044
15SW_C6	5.24	26	350	0.0044
15SW_C5	4.77	26	350	0.0044
15SW_C4	4.12	26	350	0.0044
15SW_C3	5.31	26	350	0.0234
15SW_C2	3.86	26	350	0.0234
15SW_B7	4.06	26	350	0.0044
15SW_B6	5.61	26	350	0.0044
15SW_B5	4.95	26	350	0.0044
15SW_B4	4.36	26	350	0.0234
15SW_B3	5.49	26	350	0.0044
15SW_B2	2.96	26	350	0.0044
15SW_A8	2.60	26	350	0.0044
15SW_A7	3.76	26	350	0.0044
15SW_A6	3.05	26	350	0.0044
15SW_A3	2.42	26	350	0.0044
15SW_A2	0.30	26	350	0.0044
Total/Average	123.32	26	350	0.0136

Source: X:\015\CSO 15 Separation LLM\cso 15 separation subbasins llm.xls



Opinion of Probable Cost

Description: **CSO Basin 15 Full Separation - XP-SWMM**

Project: City of Spokane CSO

CSO Basin 15

Location: Entire Basin 15 including outfall upgrades

Table No. **5**

By: LLM

Date: 8/15/2003

Project No. 71240-300

ITEM NO	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization	1	LS	\$ 75,000.00	\$ 75,000
2	12" Diameter PVC Sewer Pipe	1,600	LF	\$ 34.00	\$ 54,400
3	15" Diameter PVC Sewer Pipe	2,000	LF	\$ 40.00	\$ 80,000
4	18" Diameter PVC Sewer Pipe	2,900	LF	\$ 43.00	\$ 124,700
5	21" Diameter Concrete Sewer Pipe	1,700	LF	\$ 52.00	\$ 88,400
6	24" Diameter Concrete Sewer Pipe	1,600	LF	\$ 57.00	\$ 91,200
7	27" Diameter Concrete Sewer Pipe	600	LF	\$ 73.00	\$ 43,800
8	30" Diameter Concrete Sewer Pipe	900	LF	\$ 100.00	\$ 90,000
9	36" Diameter Concrete Sewer Pipe	1,100	LF	\$ 120.00	\$ 132,000
10	42" Diameter Concrete Sewer Pipe	900	LF	\$ 130.00	\$ 117,000
11	48" Diameter Concrete Sewer Pipe	1,500	LF	\$ 190.00	\$ 285,000
12	54" Diameter Concrete Sewer Pipe	700	LF	\$ 200.00	\$ 140,000
13	Manhole, Type I-48	27	EA	\$ 2,200.00	\$ 59,400
14	Manhole, Type I-54	4	EA	\$ 4,000.00	\$ 16,000
15	Manhole, Type II-96	3	EA	\$ 9,000.00	\$ 27,000
16	Manhole, Type III-54	11	EA	\$ 4,500.00	\$ 49,500
17	Manhole, Type III-72	3	EA	\$ 8,500.00	\$ 25,500
18	Manhole, Type III-96	7	EA	\$ 10,000.00	\$ 70,000
19	Connect Catch Basin Lines	80	EA	\$ 300.00	\$ 24,000
20	Asphalt Concrete Removal	49,700	SY	\$ 2.00	\$ 99,400
21	Asphalt Concrete Pavement, 3" Thick	49,700	SY	\$ 8.00	\$ 397,600
22	Sawing Flexible Pavement	2,500	LF	\$ 1.50	\$ 3,750
23	Crushed Surfacing Top Course	9,400	CY	\$ 30.00	\$ 282,000
24	Clearing and Grubbing	5,600	SY	\$ 2.00	\$ 11,200
25	Surface Restoration Unimproved Areas	6,800	SY	\$ 3.00	\$ 20,400
26	CDS Swirl Concentrator	1	LS	\$663,000	\$ 663,000
27	Construction Subtotal				\$ 3,070,250
28	Construction Contingency @ 15%				\$ 460,500
29	Engineering Design @ 10%				\$ 307,000
30	Construction Management @ 15%				\$ 460,500
	Project Total				\$ 4,300,000

Source: X:\015\CSO 15 Separation LLM\Basin 15 - Full Separation - LLM.xls



Table 7 Comparison of Separation and Outfall Costs		
Method	Capital Costs	
	Separation	Outfall
SCS TR-55	\$4,300,000	\$730,000
XP-SWMM	\$4,300,000	\$720,000



Table 8
Summary and Comparison of Piping Requirements Based on Both Methods of Analysis

New Pipe Name	Diameter (inches) by SWMM Method	Diameter (inches) by SCS Method	Manhole Type Req'd by SWMM Method	Manhole Type Req'd by SCS Method	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Pipe Length (feet)
15SW_A8p	12	12	I-48	I-48	1886	1884.64	309
15SW_A7p	18	18	I-48	I-48	1884.54	1883.68	259
15SW_A6p	21	24	I-48	I-54	1883.48	1883.38	50
15SW_A5p	21	21	I-48	I-48	1883.18	1882.93	95
15SW_A4p	18	18	I-48	I-48	1882.73	1880	304
15SW_A3p	18	18	I-48	I-48	1879.8	1875.9	403
15SW_A2p	27	24	III-54	III-54	1875.7	1875.48	109
15SW_A1p	27	24	I-54	I-54	1875.28	1875.02	130
15SW_B7p	18	18	I-48	I-48	1889	1887	371
15SW_B6p	21	21	I-48	I-48	1886.9	1885.99	351
15SW_B5p	24	27	III-54	III-54	1885.89	1885.32	284
15SW_B4p	24	24	I-54	I-54	1885.22	1881	368
15SW_B3p	24	24	III-54	III-54	1880.9	1876	311
15SW_B2p	36	42	I-54	II-72	1874.72	1874.06	330
15SW_B1p	36	42	III-54	III-72	1873.96	1873.28	339
15SW_C7p	15	15	I-48	I-48	1891	1888	373
15SW_C6p	18	21	I-48	I-48	1887.9	1886	318
15SW_C5p	21	21	I-48	I-48	1885.9	1884	291
15SW_C4p	21	21	I-48	I-48	1883.9	1879	364
15SW_C3p	21	21	I-48	I-48	1878.9	1873.28	316
15SW_C2p	36	36	III-54	III-54	1872.984	1868.5	351
15SW_C1p	42	48	III-72	III-72	1868.4	1867.78	309
15SW_D8p	15	15	I-48	I-48	1893	1892	237
15SW_D7p	15	15	I-48	I-48	1891.9	1888	381
15SW_D6p	18	21	I-48	I-48	1887.9	1887.49	124
15SW_D5p	21	21	I-48	I-48	1887.39	1886.90	187
15SW_D4p	24	24	III-54	III-54	1886.803	1886	284
15SW_D3p	18	18	I-48	I-48	1885.9	1877	372
15SW_D2p	18	21	I-48	I-48	1876.9	1867.78	311
15SW_D1p	42	36	III-72	III-54	1867.482	1861	319
15SW_E4p	12	12	I-48	I-48	1886	1882	315
15SW_E3p	15	15	I-48	I-48	1881.9	1879	336
15SW_E2p	15	15	I-48	I-48	1878.9	1870.3	320
15SW_E1p	27	27	III-54	III-54	1870	1867.78	320
15SW_F3p	12	12	I-48	I-48	1884	1879	321
15SW_F2p	12	12	I-48	I-48	1878.9	1872	321
15SW_F1p	24	24	III-54	III-54	1871.7	1870.3	346
15SW_G3p	12	12	I-48	I-48	1882	1878	321
15SW_G2p	15	15	I-48	I-48	1877.9	1876	318
15SW_G1p	18	18	I-48	I-48	1875.8	1872	361
15SW_T4p	54	54	III-96	III-96	1861	1860	382
15SW_T3p	54	54	III-96	III-96	1860	1859.5	120
15SW_T2p	54	60	III-96	III-96	1859.5	1859.45	30
15SW_T1pB	48	48	III-96	III-72	1859.45	1857.1	210
37009pB	48	54	II-96	II-96	1857	1855.99	336
37008pB	48	54	II-96	II-96	1855.79	1855.04	250
37007pB	48	54	II-96	II-96	1854.84	1854.22	208

Combined Sewer Overflow Reduction System Wide Alternative Report
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12/23/2005



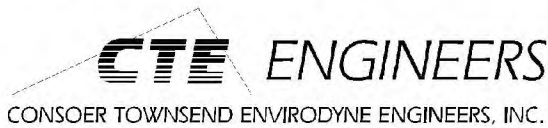
<p>Table 8</p> <p>Summary and Comparison of Piping Requirements Based on Both Methods of Analysis</p>							
New Pipe Name	Diameter (inches) by SWMM Method	Diameter (inches) by SCS Method	Manhole Type Req'd by SWMM Method	Manhole Type Req'd by SCS Method	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Pipe Length (feet)
37006pB	48	54	III-96	III-96	1854.02	1853.34	225
37005pB	48	54	III-96	III-96	1853.14	1852.48	220
37004pB	30	21	III-54	III-48	1852.28	1824	214
37040pB	42	30	III-72	III-54	1824	1815	224
37039pB	30	18	I-54	I-48	1815	1757	160
37038pB	30	27	III-54	III-54	1757	1742	200
37037pB	30	27	III-54	III-54	1742	1730	300
37036p	54	30	III-96	III-54	1730	1726	110



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Combined Sewer Overflow Reduction System Wide Alternative Report
A-42

12/23/2005



MEMORANDUM

140 SOUTH ARTHUR STREET • SUITE 500 • SPOKANE, WA. 99202 • (509) 535-5454 • FAX (509) 535-5725

TO: CSO PMO Team **cc:** file
FROM: Russell Mau
DATE: October 30, 2003 **PROJECT #:** 71240
SUBJECT: Refinement of Separation Cost Estimates for CSO Basin 41

This memorandum describes a refinement of stormwater separation costs for CSO Basin 41. This is a companion memorandum to a similar memorandum prepared for CSO Basin 15 and to a memorandum that has been prepared to document refined cost estimates for storage.

BACKGROUND

During initial analysis of CSO reduction alternatives for CSO Basin 41, it was determined that separation would be the most cost-effective alternative for this basin. Separation was estimated to cost approximately \$2.7 million while storage was estimated at \$3.6 million. This separation cost was based on a unit cost factor of \$17,607 (2002 \$) per acre applied to a gross area (plus the cost of primary treatment and allied costs such as engineering, construction management, administration, and contingency), where this unit cost was developed from historical cost data for projects completed throughout the United States. Through all subsequent analyses, separation, at a cost of \$2.7 million, remained the preferred alternative for CSO Basin 41. This refinement of separation costs, where CSO storage costs have already been refined, will be used to confirm the cost-effectiveness of separation.

CSO BASIN 41 DESCRIPTION

CSO Basin 41 is located in East Spokane, North of the Spokane River. It covers approximately 102 sanitary acres and 89 runoff acres. The regulator for CSO Basin 41 is located at the intersection of Rebecca and Upriver Drive. The current CSO threshold for CSO Basin 41 is estimated to be 1.08 cfs (0.70 mgd).

SEPARATION ANALYSIS USING SCS TR-55 METHOD

According to City of Spokane Design standard 6.2-2, Runoff Calculations □ Drainage Areas over 10 Acres, runoff from areas larger than 10 acres should be analyzed using the Tabular Hydrograph method or Graphical Peak Discharge method presented in the U.S. Soil Conservation Service □ Technical Release 55 (SCS TR-55), Urban Hydrology for Small Watersheds. According to Table 6-A from the City of Spokane design standards, new storm sewer laterals and trunks should be designed to a 10 year design storm. A non-beta (see Precipitation and Snowmelt Analyses and Design Event Development for CSO Reduction Alternative Evaluation □ CTE Engineers 2002) adjusted 10 year design storm was used in this analysis in accordance with City of Spokane design standards.



Basis of Runoff Calculation

Using ArcGIS, several sub basins were created to determine sizing of loading areas and their parameters to be used in the SCS TR-55 method of calculating runoff. The parameters used are shown in Table 1. These parameters were input into the WinTR-55 program provided by the U.S. Department of Agriculture. WinTR-55 is a windows based program released by the USDA for use in calculating runoff in small watersheds using the SCS TR-55 method. This program complies with the City of Spokane design standard of using the SCS TR-55 method for calculating runoff. The time of concentration for all sub basins was set at the minimum of 0.1 hours to be the most conservative.

Basis of Sizing Storm Drainage Piping

A basic layout of new storm sewers to be added was created and is shown in Figure 1. The SCS TR-55 method may also calculate a time delay for pipe flow if desired, however, in this analysis, pipe flow time was not estimated and runoff peak flow rates were added without delay or attenuation to create a conservative estimate of conveyed runoff flow rates and subsequent pipe diameters. Such an approach does result in an increasingly more conservative estimate of peak flow rates as the calculations progress downstream in the system. Table 1 lists the peak flow rate from each sub basin as calculated by the WinTR-55 program, where these peak flow rates were used to size the storm drainage piping.

Storm Drainage Piping Sizing Results

Table 2 summarizes the required pipe capacities based on the WinTR-55 output, their scaled lengths, estimated slopes, and calculated diameters, along with the calculated capacity of the pipe for the given diameter and slope.

Pipe diameter calculations were based on a full flow pipe using Manning's equation with a hydraulic roughness or n factor set at 0.013. The selected diameter was either equal to the calculated value or the next larger, manufactured diameter.

COSTS

Table 3 presents a summary of the cost estimates for separation for CSO Basin 41. Unit prices used in generating the values in Table 3 were taken from the Basis of Cost report (CSO PMO, 2002). At this level of analysis, the pipes are assumed to conform to City of Spokane design standards with at least 3 feet of ground cover and minimum slopes as specified in City of Spokane Municipal Code Section 6.3-7.

According to the results of the SCS TR-55 method of estimating runoff flow rates and calculating stormwater drainage facility sizing and subsequent cost estimates for the sized facilities, it is estimated that the capital cost of separation of CSO Basin 41 will be approximately \$2,640,000, which yields a total area unit cost factor of \$29,700 per acre. This cost includes a vortex type unit for primary treatment of the stormwater in anticipation of future regulations.

Removing allied costs such as engineering, construction management, administration and contingency (a cumulative 40% of the construction cost, as estimated by the CSO PMO) and subtracting the cost of primary treatment yields an area unit cost factor of \$16,600 per acre. This unit cost can be compared to the previously used unit cost factor of \$17,607 per acre.



CONCLUSIONS

The area unit cost factor for separation only (not including costs for primary treatment and allied costs) determined in this analysis for CSO Basin 41 □\$16,600 per acre □is similar to the previously used unit cost factor, which was \$17,607 per acre, so no significant changes in cost estimating for separation is warranted.

For all future separation cost estimating, an area unit cost factor of \$21,000 (2003 \$), which does not include the costs for primary treatment and allied costs, will be used, which matches the greater value reported in the companion memorandum for CSO Basin 15.

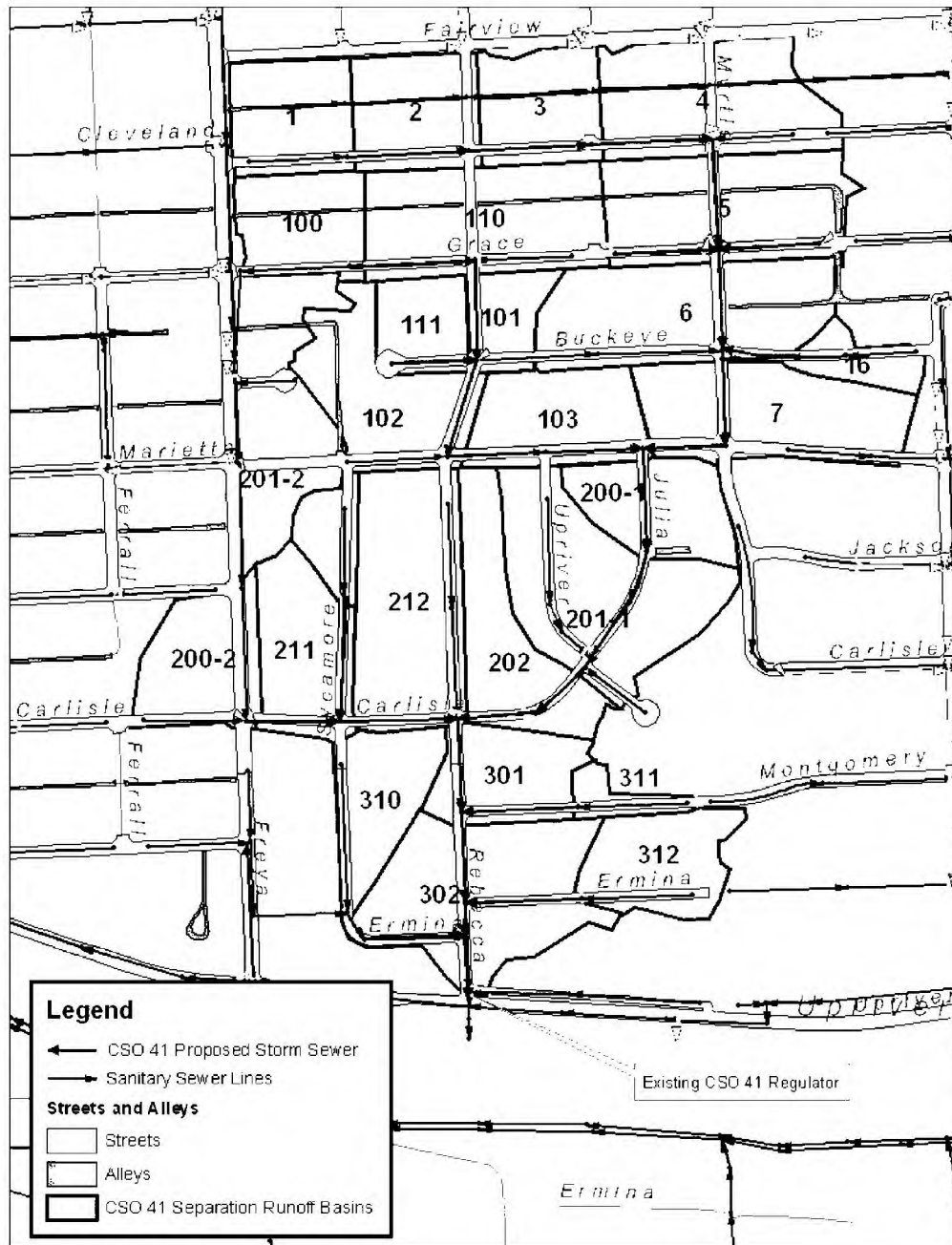


Figure 1

Storm Drainage System Conceptual Layout and Runoff Subbasins for CSO Basin 41



Table 1
Summary of Runoff Parameters for CSO Basin 41

Subbasin Area Number	Drainage Area (acres)	Time of Concentration (hrs)	Curve Number	10-Year Storm Peak Flow Rate (cfs)
1	2.75	0.1	77	1.65
2	3	0.1	79	2.19
3	2.76	0.1	77	1.66
4	4.96	0.1	78	3.29
5	5.2	0.1	78	3.45
6	5.65	0.1	78	3.75
7	4.76	0.1	73	1.92
16	1.15	0.1	80	0.92
100	2.6	0.1	77	1.56
101	1.49	0.1	80	1.19
102	3.99	0.1	78	2.64
103	1.62	0.1	82	1.53
110	5.15	0.1	78	3.41
111	1.72	0.1	78	1.14
200-1	2.78	0.1	81	2.42
200-2	3.04	0.1	71	0.96
201-1	6.03	0.1	78	4.00
201-2	1.19	0.1	80	0.95
202	3.68	0.1	77	2.21
211	3.16	0.1	78	2.10
212	5.57	0.1	78	3.69
301	2.64	0.1	79	1.93
302	5.96	0.1	78	3.95
310	2.64	0.1	78	1.75
312	2.82	0.1	77	1.70
311	0.72	0.1	83	0.74



Table 2
Summary of Required and Calculated Storm Drainage Pipe Capacities for CSO Basin 41

Subbasin Area Number	Required Capacity (cfs) (from SCS TR-55)	Diameter (in)	Scaled Length (ft)	Estimated Slope	Calculated Pipe Capacity (cfs) (from pipe diameter and slope)	Assumed Pipe Type
1	1.7	12	360	0.0097	3.51	PVC
2	3.8	12	360	0.0153	4.41	PVC
3	5.5	15	360	0.0097	6.36	PVC
4	8.8	18	323	0.0108	10.92	PVC
5	12.2	21	295	0.0102	16.00	PVC
5	1.5	8	300	0.0154	1.50	PVC
5	1.5	12	300	0.0100	3.56	PVC
6	16.9	24	12	0.0083	20.61	PVC
7	18.8	24	231	0.0108	23.51	PVC
7	18.8	24	262	0.0092	21.70	PVC
16	0.9	12	190	0.0058	2.71	PVC
16	0.9	12	355	0.0056	2.67	PVC
100	1.6	12	370	0.0041	2.28	PVC
101	7.3	21	330	0.0039	9.89	PVC
102	9.9	18	291	0.0137	12.29	PVC
102	9.9	18	295	0.0102	10.61	PVC
110	5.0	18	280	0.0043	6.89	PVC
111	1.1	12	260	0.0058	2.71	PVC
202	38.9	36	196	0.0046	45.23	Conc.
202	38.9	36	27	0.0074	57.37	Conc.
211	4.1	15	341	0.0117	6.99	PVC
212	46.6	42	230	0.0028	53.23	Conc.
301	47.3	42	280	0.0027	52.28	Conc.
302	56.7	42	280	Outfall		Conc.
302	55.0	42	90	0.0033	57.79	Conc.
302	51.0	42	278	0.0027	52.28	Conc.
310	1.8	12	294	0.0136	4.15	PVC
310	1.8	12	96	0.0104	3.63	PVC
311	0.7	8	350	0.0114	1.29	PVC
312	1.7	12	350	0.0107	3.69	PVC
200-1	32.7	30	315	0.0095	39.98	Conc.
200-2	1.0	8	287	0.0087	1.13	PVC
201-1	36.7	30	175	0.0086	38.04	Conc.
201-1	36.7	30	175	0.0114	43.79	Conc.
201-2	1.0	8	316	0.0222	1.80	PVC



Table 3
Cost Estimate Summary for Separation Based on SCS TR-55 Method

 Opinion of Probable Cost					
Description: CSO Basin 41 Full Separation			Table No.	3	
Project: <u>City of Spokane CSO</u>			By:	MDM	
<u>CSO Basin 41</u>			Date:	8/20/2003	
Location: <u>Entire CSO Basin 41 above regulator</u>			Project No.	71240	
ITEM NO	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization	1	LS	\$ 60,000.00	\$ 60,000
2	8" Diameter PVC Sewer Pipe Installed	1,250	LF	\$ 32.00	\$ 40,000
3	12" Diameter PVC Sewer Pipe Installed	3,000	LF	\$ 31.00	\$ 93,000
4	15" Diameter PVC Sewer Pipe Installed	700	LF	\$ 36.00	\$ 25,200
5	18" Diameter PVC Sewer Pipe Installed	1,200	LF	\$ 42.00	\$ 50,400
6	21" Diameter PVC Sewer Pipe Installed	650	LF	\$ 50.00	\$ 32,500
7	24" Diameter PVC Sewer Pipe Installed	550	LF	\$ 67.00	\$ 36,850
8	30" Diameter Concrete Sewer Pipe Installed	700	LF	\$ 120.00	\$ 84,000
9	36" Diameter Concrete Sewer Pipe Installed	350	LF	\$ 144.00	\$ 50,400
10	42" Diameter PVC Sewer Pipe Installed	1,200	LF	\$ 166.00	\$ 199,200
11	Stormwater Treatment Unit: Primary	1	EA	\$ 406,000.00	\$ 406,000
12	Pavement Removal and Replacement	37,500	SY	\$ 10.00	\$ 375,000
13	Crushed Surfacing Base Course	12,500	CY	\$ 25.00	\$ 312,500
14	Sawing Flexible Pavement	1,000	LF	\$ 1.50	\$ 1,500
15	Connect Catch Basin Lines	30	EA	\$ 100.00	\$ 3,000
16	Manhole, Type I-48	22	EA	\$ 2,200.00	\$ 48,400
17	Manhole, Type I-54	8	EA	\$ 4,000.00	\$ 32,000
18	Manhole, Type II-72	6	EA	\$ 6,000.00	\$ 36,000
	Construction Cost Total				\$ 1,885,950
1	Construction Contingency @ 15%	1	L.S.	\$ 282,892.50	\$ 282,893
2	Engineering Design @ 10%	1	L.S.	\$ 188,595.00	\$ 188,595
3	Construction Management @ 15%	1	L.S.	\$ 282,892.50	\$ 282,893
	Capital Cost Total				\$ 2,640,330



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